Politecnico di Torino

Master's Thesis

" The Role of Off-Grid Solar Electrification Sustainability in the Economic Growth of Pakistan"

Master of Science in Engineering Management

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Acknowledgement

Pakistan since its inception is facing an energy crisis. Government officials have come and gone throughout the years, but it seems like the country's leaders have not yet been given the highest importance to seriously ameliorating the energy crisis. However, different tiers of the economy have been suffered badly from acute energy supply. Resultantly, industries, agriculture, and the service sector has been unable to perform to the full extent and continuously failed to achieve better results. Because of this, the economic condition of Pakistan is worsening day by day. The main aim of the research is to identify the impacts and opportunities of off-grid electrification in Pakistan. Furthermore, how the atmosphere of green energy and off-grid electrification can be promoted in the country. That makes residents of Pakistan produce electricity through solar energy on their own. In this way, they can fulfil their needs for electricity without relying on the governmental structure. In addition to that, research also has been done on the challenges regarding the proper establishment of an off-grid electrification system in Pakistan and are policies that have made concerning off-grid electrification. The research has consisted of statistical data, quantitative information, and empirical information. The references which are used in the research are done by experts of that particular field of studies along with the governmental reports related to this subject.

I would like to thank my supervisor Professor. Luigi Benfratello, who not only guided me but helped me to design the research process, I am thankful for your unwavering support.

Table of Contents

Chapter One

Pakistan overview

1 Chapter I: Pakistan overview

1.1 Historical Prospective of Pakistan

Pakistan is the word combine form of two words which are “Pak” and “Istan”. The Word Pak is a Persian Language word that means pure or clean. Whereas the word Istan is a Hindi word that means to place. The meaning of Pakistan is Pure land. Pakistan came into existence as a sovereign independent state on the world map on 14th August 1947 from the division of the subcontinent into two separate nations another one in India from the British Empire rule.

The traces of Pakistan’s history back to at least 2,500 years before Christ, when a highly developed civilization flourished in the Indus Valley area. Around 1500 B.C, Aryans were the rulers of the region and whose rule affected the Hindu civilization; because of this, the centre of Hindu civilization moved to the Ganges valley. After the Aryans, Persians conquered this piece of land in about 5th B.C and continuously ruled this region up to 2nd Century A.D. Not only Aryans and Persians influenced and ruled the subcontinent but also Greeks came to the subcontinent in 327 B.C under the leadership of Alexander - The Great.

Before the advent of Muhammad Bin Qasim, a Muslim Leader in 712 A.D in the region of Sindh – which is currently is one of the provinces of Pakistan, the residents of the sub-continent were Hindus. During that time, Islam was preached in the region and changed the life, culture, and tradition of the people of the Subcontinent. Besides Muhammad Qasim, many Muslim and Hindu rulers ruled the region. But, in 1757, a new player entered the race of power play in the region and conquered the throne of the subcontinent and that new player was British Empire [1]. The flag and rule of the British Empire lasted about 200 years in the Subcontinent. In 1947, after getting the freedom from British Empire, the subcontinent was divided into two nations – India and Pakistan.

Pakistan under the Leadership of Quid-e-Azam Muhammad Ali Jinnah became a sovereign state. After independence, Pakistan welcomed about 10 to 12 million refugees from Hindu majority regions of India [2]. These peoples belong to different races, cultures, and colours. But Pakistan welcomed them open-heartedly and helped them lead an easy and peaceful life in a new country. Consequently, Pakistan has become a culturally, ethically, linguistically, and racially diverse country. Pakistan comes into being by popular demands of Muslims of the subcontinent to have a separate Muslim state where they practice their religious duties and lead life in the Islamic way without any hindrances. Officially in 1956, Pakistan became an Islamic republic because of the introduction of the 1956 constitution. Since

independence till 1971, Pakistan was composed of two regions the West-Pakistan and East-Pakistan [3]. The west part of Pakistan is in the Indus River Basin in the northwest of the Indian Subcontinent. While East- Pakistan was located about 1600 Kilometres east in the vast delta of the Ganges-Brahmaputra River system. Due to unfortunate incidents, civil war occurred between East and West Parts of Pakistan in 1971. Consequently, East Pakistan separated itself from Pakistan and proclaimed a separate and independent state called Bangladesh.

Apart from that, Pakistan is a country that has the 6th largest population in the world [4]. Besides, the People of Pakistan have been ranked 4th most intelligent people worldwide by the Institute of European Business Administration in which institution considered 125 countries for the report making. Pakistan is a country that has the 7th largest number of scientists and engineers. It is the country of tallest mountains and has the second largest and oldest salt mine in the world. Pakistan has the 6th largest standing army in the world and is a nuclear-powered nation. Pakistan counted among the evolving and growing economies of the world and its economic growth is strongly supported by its economically strengthening middle-class population.

Additionally, Pakistan is a member of many internationally recognized organizations. Pakistan became a member of the United Nations in 1947 and has been elected a member of the Security Council of the United Nations seven times. In addition, the Pakistani diplomat Muhammad Zafarullah Khan has served as the President of the United nation in 1962 [5]. Apart from that, Pakistan is also an active member of the World Health Organization (WHO). Pakistani government with WHO has helped about 1.5 million affected people from different natural disasters such as floods and earthquakes and chronic security issues by helping them shifting to a safe location from chaotic locations. World Health Organization is working hard to uproot the Polio from Pakistan and the Pakistani government actively participate in WHO projects for the betterment of Pakistani citizens. Other wells unknown organizations whose Pakistan is an energetic member Commonwealth of Nations, South Asian Association for Regional Cooperation (SAARC), Organization of Islamic Cooperation (OIC), Shanghai Cooperation Organization (SCO) and Economic Cooperation Organization (ECO).

1.1.1 Pre-partition History

Before, the independence of Pakistan, it was subcontinent which was composed of India and Pakistan. Subcontinent was ruled by British Empire. Through the establishment of East India company, British started their journey towards acquiring the crown of subcontinent. However, British domination in India was started when they topple the Tipu Sultan of Mysore from throne in 1799 [6]. Their power rise gradually over a period of one hundred years.

By 1845, British Empire boundaries were expended to Sindh from Bengal. The British rule was stretched from Khyber Pass. Queen Victoria became first Queen of England who became the Empress of India in 1877 [2]. During her era, Empire was extended to Afghanistan. Consequently, Durand Line was drawn by Britishers as a boundary of empire.

However, the British rule was socially and politically conservative. But it introduced weighty economic and administrative developments to subcontinent. British Raj had established communication and

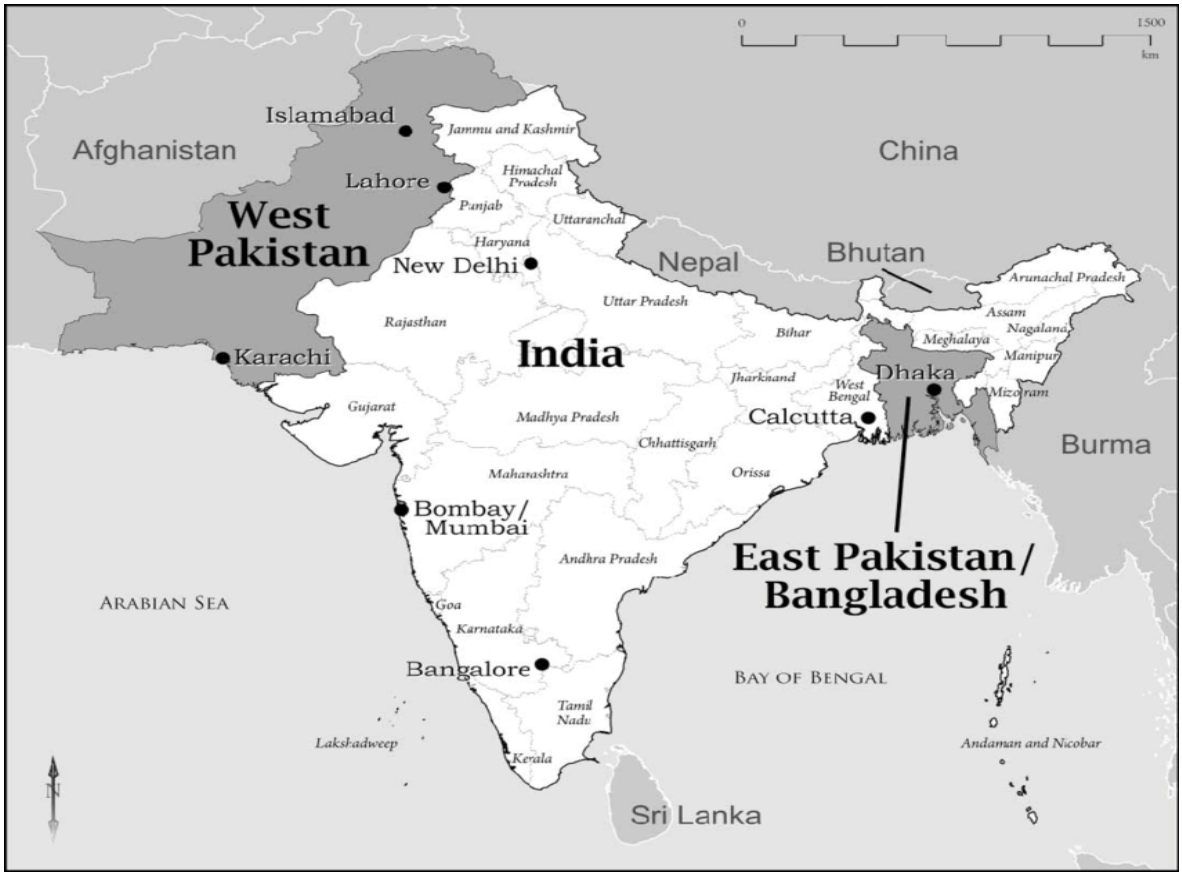


Figure 1: Map of Subcontinent

Source: Map by Julius Paulo

transportation channels along with railway network in the region for the administrative, commercial, and strategic reasons. In addition to that, Britishers introduced couple of constitutions and regulations acts to regulate the governing process in the region. The changes were the best things what they had done for the people of subcontinent.

Nevertheless, People were not happy with the Raj. By the end of 19th Century, several activities have been started to acquire their freedom form Britishers. Two main political parties were leading these movements which were the Indian National Congress which was formed in 1885 and All India Muslim League which was established in 1905 [1]. These both political parties were struggling to get rid of British Raj. The aim of All India Muslim League was to protect rights especially of Muslim community of Subcontinent. Whereas Indian Congress were claiming their motive was to protect rights of every resident of region. But Congress failed to do so. Resultantly, Muslim formed their own political party after 20 years of establishment of Indian National Congress Party.

Several movements were carried out for the freedom from British raj. Home Rule moment was one of them. The moment was started by Annie Besant and Bal Gangadhar in 1916 for self-rule over the subcontinent instead of Britishers. But the league was short-lived and did not provide fruitful results. However, Congress started non-cooperation movement against the Britishers. Non-cooperation was lunched in 1920 by Mahatma Gandhi – the prominent leader of Indian National Congress for achieving self-governance acquiring freedom from dominance of Britishers. There was an unfortunate Chauri Chaura incident occurred while experiencing non-cooperation movement in Gorakhpur district of the United Province – its current name is Uttar Pradesh. Chauri Chaura incident took the lives of 22 policeman and 3 civilians while experiencing non- cooperation [1]. That's why, Gandhi called-off the non-cooperation movement in 1922. Gandhi also lunched another league against the Britishers was a Civil Disobedience Movements. The league was initiated on 12th March 1930 [2]. This movement was started when Britisher introduced Salt Act in the subcontinent which forced the Indians to purchase minerals from Britishers instead of purchasing their own country's minerals. Gandhi along thousands of people marched on Costal town of Dandi on the Arabian Sea. As a result, Gandhi was arrested and released after some-time. Later, Britishers abrogated the salt act.

The year 1930 was the turning point in the history of Subcontinent. Before, Muslims of India never demanded a separate nation or state. They always demanded their basic rights and state within state. But in 1930, during the session of All India Muslim League at Allahabad, Allama Muhammad Iqbal – the greatest poet-philosopher-politician of subcontinent said, "I would like to see the Punjab, North-West Frontier Province, Sindh and Baluchistan amalgamated into a single state. Self-government within the British Empire or without the British Empire, the formation a consolidated North-West

Indian" [2]. To him, Muslim state is the only solution for the survival of Muslims in the subcontinent. This address paved the way to the creation of Separate state for Muslims of India. Consequently, All India Muslim under the Leadership of Quaid-e-Azam Muhammad Ali Jinnah pursued the dream of Allama Iqbal. Resultantly, a Muslim state was formed in 1947 on 14th August [3].

1.1.2 Post-partition History

On the 14th of August, Pakistan came into being. Muslim League was a major political party, it selected the Quaid-e-Azam Muhammad Ali Jinnah as the Governor-General of Pakistan. Very few countries came into existence as a separate nation without any resources. That was a case with Pakistan. The newly created state neither inherited a central government, a capital, an administrative system nor an organized defence mechanism. However, that new position of Governor-General of Pakistan accompanied with complicated duties for Jinnah such as refugees' issues, economic matters, Kashmir issue and administrative problems. Quaid-e-Azam to confront with the economic issues of Pakistan created the State Bank for Pakistan which independently overcame the currency issues and financial matters of country. In addition, Jinnah selected Karachi as a governing base for the country and established a federal Assembly there.

Figure 2: Map of Pakistan in 1947

Source: Map created by Themightyquill

The first Constitutional assembly of Pakistan formed with the help of Indian Independence Act 1947. The assembly was consisted with 79 members out of which 60 members were the members of Muslim league. Other were the members of National Congress that was the largest political party after Muslim League. The assembly was called on 10th August 1947 in the building of Sindh Assembly Karachi. Assembly elected Jinnah as a President of Pakistan and for Deputy President Maulvi Tamizuddin Khan as elected. On the same day, National Flag of Pakistan was officially approved by the national assembly. However, the assembly was working properly due to lack of proper regulations, Therefore, the First prime Minister Nawabzada Liaquat Ali Khan passed the Objective Resolution from the National Assembly in 1949. In the resolution, the basic norms were explained of newly formed country. So, the first continuation of Pakistan was formed in 1956 which was presented by Chaudhry Muhammad Ali in the National Assembly. through adoption of this constitution, Pakistan formerly became an Islamic Republic [7].

After two years of approving a constitution, an unfortunate incident occurred which abrogate the constitutional assembly by imposing of martial law. Martial Law was introduced by Muhammad Ayyub Khan in 1958 by overthrowing the government of President Iskandar Mirza. In addition, General Ayyub formed the commission for the formation of another constitution for the proper functionality of administrative and governmental system in the country. The objective commission drafted the report. A new constitution was drafted with respect to the report of objective commission. Officially, the new constitution approved by assembly on the 28th of March 1962 [7]. This new constitution introduced presidential form of governing system in the country along with National Assembly at the Centre and the provincial assemblies in the provinces. The term of assembly was defined for the three years. After a long martial law rule in the country, general elections were held in Pakistan during 1970s. the election bring the atmosphere of the democracy in the country. Pakistan people's Party formed the government in the major province of West Pakistan and Awami League form government in the East Pakistan. However, there was a strong bitterness among the East and West Pakistan regions. This bitterness led to civil war in the country. The result of that civil was the breaking of Pakistan into two parts – Pakistan and Bangladesh. Bangladesh came into existence on 26th March 1971 [3].

The era of 70s was not good for Pakistan in-terms of stability. Another unfortunate incident occurred in the history of Pakistan that was again overthrowing democratic government of Pakistan People's party by then Army Chief, General Muhammad Zia-ul-Haq on 5th July 1977 [8]. The rule was tough for the people of Pakistan. General Zia implemented the policies for the development and progress of Pakistan were based on the building of Islamic empire. People were not happy with the rule of General Zia. He pressed hard people by restricting their basic freedom rights. After the death of General Zia in

Figure 3: Map of Pakistan after separation of East Pakistan from West Pakistan

Source: Survey of Pakistan

plane crash in 1988, people elected Benazir Bhutto as their first Lady Prime Minister of Pakistan [7]. The phase of late 1980s and early 1990s was governed by Pakistan People's party and Pakistan Muslim League under the leadership of Mian Muhammad Nawaz Sharif. This phase was most un-stabilized phase in the history of Pakistan because governments were not able to complete their legal tenure due to corruption, political instability, economic recession and growing of all social ills in the society hindered the smooth running of governments. This caused military coup in 1999. Coup was implemented by General Pervez Musharraf.

The early days of Musharraf era proved beneficial for the people of Pakistan. Pakistan shows better growth in the macro-economic indicators of economy, improvements in education standards, decreasing of poverty in the country. But the goldens days were not lasted long due to Pakistan support to America on the War on the terrorism. This act of support destroyed the economy and infrastructure of country. Apart from that, Pakistan played most important role in the fight against terrorism. Again, in Pakistan in 2008, democratic rule nurtured in Pakistan. Since then, Pakistan is experiencing the democracy in the country. This practice of democracy helped the Pakistani people in understanding the importance of their voting rights and taught them importance about the political stability.

1.2 Geography

Pakistan is situated in the South Asia and enjoy great strategic position due to its location. It acts as a junction between Central and Middle East Asia. Pakistan has a wide range of its borders with four different countries. The border length of Pakistan is about 6,774 Kilometres. Pakistan shares its borders with India in East, in the west with Iran and Afghanistan and with China in the northeast side. In the fourth side, the land of Pakistan is sharing border with Arabian sea which adds more important to its strategic position and the coastline of Pakistan is of 1,046 kilometres.

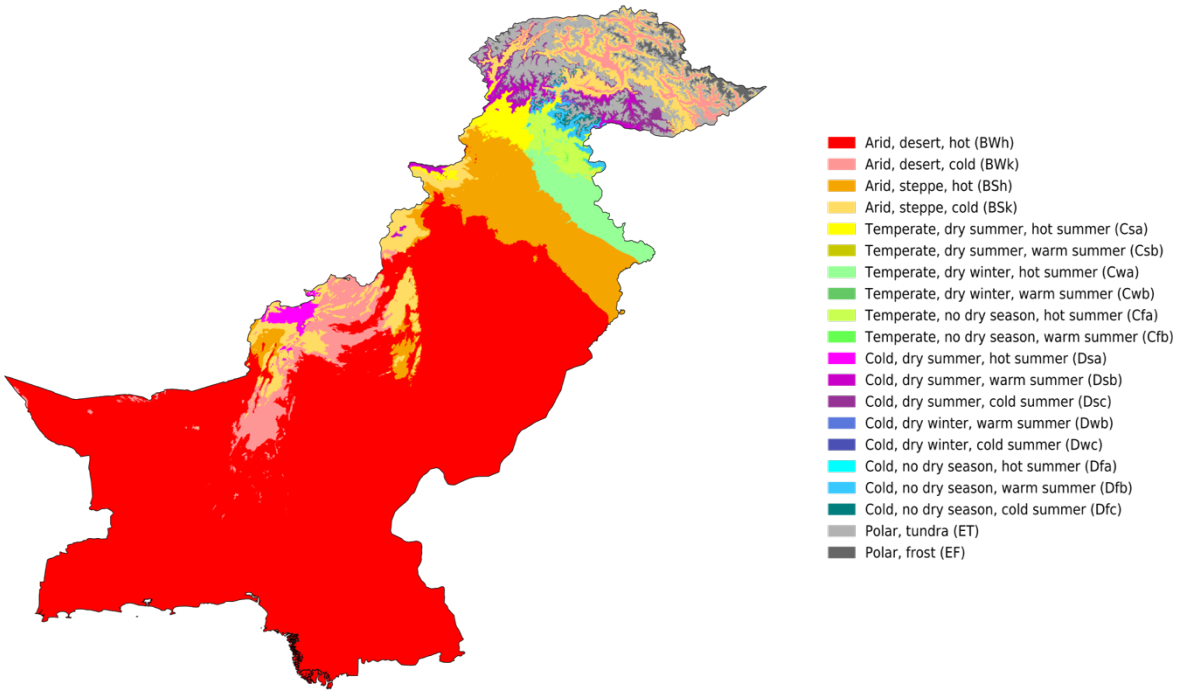


Figure 4: climate classification map of Pakistan

Source: Koppen Geiger climate classification map for Pakistan

The border between Pakistan and China is about 523 kilometres and is situated in north-eastern Pakistan. Between 1961 and 1965, several agreements were signed defining the border between the two countries. The famous China-Pakistan Border Agreement was approved between Pakistan and China in 1963, so the two countries agreed on the border. However, the India – Pakistan border which was Radcliffe line that was drawn for the separation of subcontinent of into India and Pakistan was officially ratified as Indo-Pak border on 14th August 1947. The length of border is approximately 2.912 Kilometres long [9]. The most important place on the Indo-Pak border is a Wagah border. It is only place where people with official permission can cross the border. Otherwise, the remaining places of border are fenced. In addition to that, Pakistan also share border with Afghanistan. The border

between both countries is referred as the Durand Line and that is long about 2,430 Kilometres [2]. Durand Line was drawn in 1893 that was result of an agreement between United Kingdom and Afghanistan. It is named after the foreign secretary Sir Mortimer Durand who made the agreement with Afghanistan. Apart from that, Pakistan also shares its border with Iran. Pakistan – Iran's Obstacles is common name which is used for the Iran – Pak border and its length is approximately 909 Kilometres [8].

In terms of Climate, Pakistan is in the temperate Zone. The climatic characteristics of Pakistan generally are arid, hot summers and cold winters. The range of temperature varies from region to region. Pakistan experience four different seasons throughout a year that are winter, summer, spring, and autumn. Winter occurs in Pakistan from December to February. Generally, temperature in winter ranges averagely from 13°C to -20°C [9]. After winter, Pakistan enjoys the spring the country which starts in Mach and ends in June. In that season, little rainfall occurs in country. Pakistan do not possess the season of heavy rains. While in the summer temperature goes up to 55°C and summer weather experienced by people from June and last to September. Summer season is longest season of Pakistan. Lastly, autumn season occurs in September to December. The autumn season is good season to travel Pakistan because it is very soft in-terms of temperature. The temperature ranges to 27°C from 20°C.

Pakistan has been endowed with a plethora of mountain ranges that draw geologists and mountain climbers from across the globe. Pakistan does have over a hundred mountain peaks that are higher than 7,000 metres. Pakistan is home to four of the world's fourteen highest peaks. The highest mountains peaks are mostly discovered in the Karakoram range is one of the largest mountain peaks found in the country. The Hindu Kush Mountain range has been in the northwest. The high Hindu Kush range (Eastern Hindu Kush range) is mostly found in northern Pakistan and Afghanistan.

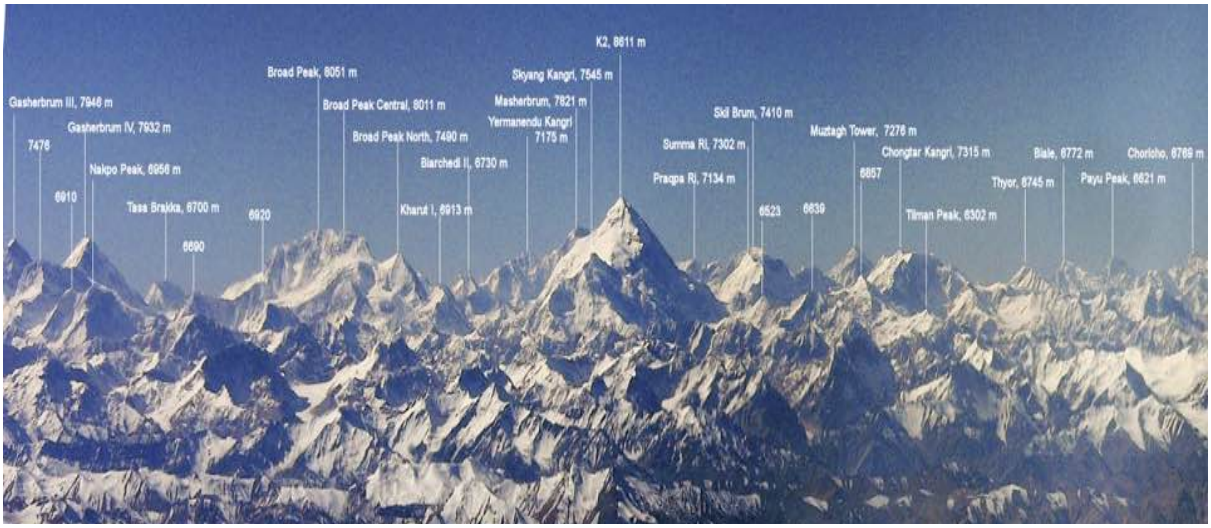


Figure 5: Mountains Range of Pakistan

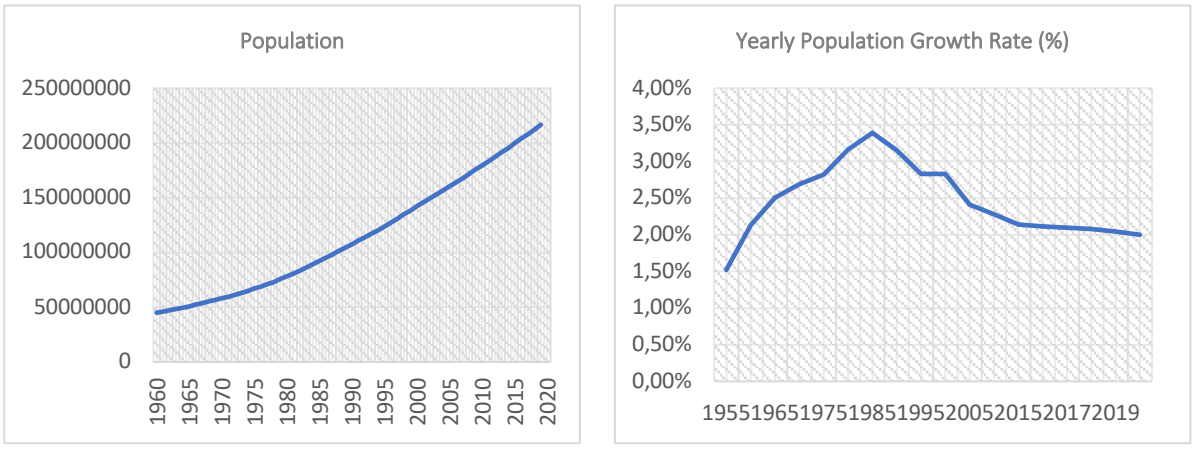
Source: himalaya-info.org/Karakorum_flug.html

In Pakistan's Northern Areas, perhaps this range can also be found in Ghizar, Yasin Valley, and Ishkoman. The highest point in the Hindu Kush range is Tirich Mir in Chitral (25,289 ft) [9]. The Karakoram is an Indian, Pakistani and China mountainous region. There are over 60 peaks in the Karakoram range that are higher than 7,000 metres [10]. This line comprises K2, which is 8,611 metres the second largest peak in the world (28,251 ft) [10]. K2 is the world's second-highest mountain, part of the range from the Himalayas to Karakorams. It is situated on the Pakistani Chinese border in the northern part of the country. Because of the difficult ascent of this mountain, K2 is also a popular destination and known as Savage Mountain. Apart from that, Nanga Parbat is a Himalayan peak on the western side of the Himalayas. It is in Pakistan's Northern Areas, south of the Indus River, in the Astore District. There is a hill system in Punjab known as 'The Salt Range.' Its name is derived from the extensive rock salt deposits that exist in the area. This ranges from the Jhelum River to Indus throughout the northern Province of Punjab. 'The Salt Range' contains the well-known salt mines of Khewra, Mayo, Wacha, and Kalabagh.

1.3 Population

Pakistan is the 5th most populous country in the world with population of about 222.86 million in the year 2020 [11]. The growth rate of its population is about 2% which is overall greater than other South Asian countries. The population of Pakistan since its inception as shows a massive growth. It has increased to six-fold from its existence. The first population census occurred in country in 1951. According to that census, the overall population of Pakistan was 75.7 million – of that 33.7 million was the population of West Pakistan and remaining 42 million was the population of East Pakistan [4].

The high development in populace in the country could be ascribed to various components. Pakistan has the most reduced preventative pervasiveness rate in South Asia, which has deteriorated at 35



Graph 1: Population and it's growth in Pakistan

Source of Data: Pakistan Bureau of Statistics

percent throughout the most recent few years. One out of five wedded ladies in Pakistan can't get to powerful techniques for family arranging on the off chance that they need to stay away from pregnancy and plan the number and dividing of youngsters. Low preventative predominance might be additionally credited to frail assistance conveyance frameworks and markets and social standards.

From 1993 to 1998, Pakistan ran a better family planning program in the country which was instrumental in diminishing fecundity rates and expanding prophylactic pervasiveness. The vital component of the program was the enrolment of prepared Lady Health Workers (LHW) to give essential medical care and family arranging administrations to ladies at network level. The LHW were essential in growing family arranging administrations to poor people and teaching them on the accessible techniques. Nonetheless, from 2000 onwards, progressive governments' consideration regarding family arranging programs began to lessen.

In any case, it is urging to take note of that populace and family arranging is presently again getting space on the public authority's approach plan. The Federal Government has introduced a Task Force for Population and Family Planning to build up a procedure for controlling populace development and managing its execution. The Task Force, headed by the Prime Minister of Pakistan which incorporates

Figure 6: Population wise map of Pakistan

Source: Pakistan Bureau of Statistics

all common Chief Ministers of all provinces of country as individuals, is trying to accomplish three key targets which are expanding prophylactic predominance rate to 55 percent, diminishing ripeness rate from 3.6 births per lady to 2.1, and diminishing populace development rate to 1.5 percent [13]. Given the lapsed administration structure in Pakistan, the incorporation of Chief Ministers in the Task Force is critical to executing an organized and far-reaching family arranging program.

Pakistan must look to other Muslim nations who had effectively controlled their populace development rates. These countries can be Bangladesh and Iran. Bangladesh's populace at its independence was round about 71 million. It was near to Pakistan’s populace of 65 million [4]. Today, the number of inhabitants in Bangladesh is approximately 164.7 million with growth of 1% per annum [11]. It introduced better plan for the birth control program in the country. The plan was to educate people for usage of contraceptive among the young married couples. Likewise, Iran had recorded the quickest drop-in ripeness fecundity rates to 1.6 per lady in 2017 from 6.5 in 1980 [13]. This is credited to a fruitful program that drew in strict foundations and presumed pastors on family arranging, expanded admittance to free contraceptives, advising for new couples and broad communications for bringing issues to light on family arranging.

Without solving the population explosion challenge, Pakistan will keep on confronting issues that leads in achieving lower positions on the Human Development Index (HDI). Information shows that quickened progress in human turn of events and decrease in populace development rate have generally happened all the while. At the point when Bangladesh outperformed Pakistan in HDI in 1997, it showed slower development in populace than Pakistan's. From 1990s to 20s, Pakistan’s populace growth was 32% whereas, the population expansion rate of Bangladesh was about 24% [12]. Population explosion cripples’ government’s delivery system. In every 8 seconds, mother gives a birth to new baby. With that birth rate, the population of Pakistan will be 350 million by 2070 [11]. Without composed, earnest and committed endeavours, Pakistan is probably not going to accomplish its 2020 objective for expanding contraceptive commonness to 55 percent as a component of its responsibility at the Family Planning Summit, 2017 [13]. An all-encompassing methodology with consideration of commonplace and different partners, is needed to plan a sound arrangement and administer its execution. The decrease in populace development rate is a significant empowering influence for quickening human turn of events and accomplishing the Sustainable Development Goals. Therefore, Pakistan needs to make a better planning and must make sure the implementation of policies of world heath organizations regarding the population control to make the country more prosperous and safer for the coming generations.

1.4 Culture

If there is a country whose culture is starkly contrasted by its international image, it must be Pakistan. Pakistan is a country who has a vibrant culture. It is a culture of mixed civilization which are Indian, Persian, Afghan, Central Asian, South Asian, and Western Asian. It is because of its historical, geographical position and due to its ethnic diversity. There is a great ethnic variety in the country. There are about 15 different ethnic groups based on their physical characteristics, historical roots, race, outfits, food, and music. Of these 15 ethic groups, some of these are Sindhis, Punjabis, Kashmiris, Baloch, Pashtuns, Hazaras and Makranis. Apart from that, the religion who has influenced most the culture of land is Islam which was introduced to region in 700 A.D by the Arab invaders.

Pakistan is a country of multi languages. The actively spoken languages in the whole country are about 76. When you travel from city to city, region to region, province to province, you will listen different languages there. Other than Urdu, which is national language, most spoken languages are Punjabi, Sindhi, Balochi, Saraiki, and Pashto.

Being a country a diversified culture, there exists a great variety of genre of music in Pakistan which are influenced by different languages and poetry. People used to listen Qawwali and Ghazals regularly. Qawwali is a music form of Sufi devotional singing which originated in subcontinent. It popular among the Sindh and Punjab provinces of Pakistan. Whereas the Ghazals are a form of romantic poem. This form of music loved most by the people of subcontinent. This country has generated great singers such as Nusrat Fateh Ali Khan and Poets like Ahmed Faraz who have influenced the culture of music and poetry greatly. Not only Ghazals and Qawwali but Pakistani people also love to listen pop music, Rock music, Jazz, and all modern form of music.

However, the national drink of Pakistan is sugar cane juice. But people used to drink a lot of Chai – in English it is known as a Tea. You can find at every restaurant and hotels of nations. It is consumed like bear and alcohol are consumed in the European countries and other parts world. Due to its huge consumption of chai, Pakistan is 3rd largest tea importer country of the world.

In Pakistan, People love to play many sports. The national sport of Pakistan is Hockey. However, People are crazy about the cricket. Even country experience holyday when in the world cup tournaments Pakistan play final match of world cup with especially with India. Apart from cricket, other spots such as squash, Polo, and badminton, are also widely played and appreciated. Polo sport is mostly played the northern parts of Pakistan. Pakistan is country who has the polo grounds at highest altitude in world.

There are some dishes are moderately cooked, for example, the acclaimed Haleem, a blend of pulses, meat and flavours that are cooked for to seven or eight hours. It's a thick stew generally presented with lemon, coriander, and ginger. Sheep meat is the mostly used meat. Ghee and yogurt are utilized in the cooking of numerous sorts of meat to achieve specific flavour in the food. Pakistani people have a culture of eating a bread with dinners that are being eaten with the correct hand and naan bread or roti used to gather up curries. Other well-known breads incorporate chapati and paratha.

The Oven Tandoor was originated in the Pakistan that is commonly used to cook huge numbers of the breads just as meats like chicken, sheep, or fish. Pakistan produced best quality rice in the world. That rice specie is with long grain basmati rice particularly valued and utilized in the exemplary biryani, a breath-taking mix of spiced rice that is typically cooked with meat however can likewise be vegan. Sweets are and Desserts also have great importance in the food culture of Pakistan. Halva (which means sweet) is one of the most mainstream desserts and can be made with flour or semolina yet can likewise be made with carrot or pumpkin. Numerous desserts are additionally imbued with fragrant substances like rosewater.

Chapter Two

Economic Performance of Pakistan Since its Inception

2 Chapter II: Economic Performance of Pakistan since its inception

2.1 Overview of Pakistan's Performance

Pakistan's performance since its inception is inspiring and disappointing. Despite that un-stabilized economic performance, the country's economy has somehow managed to survive. It is inspiring because the speedy growth has resulted in a multiplying of per capita incomes and lessening in poverty levels by one half despite high population growth. Structural changes in the institutions of Pakistan have transformed a principally agrarian economy to a more diversified economy. Consequently, Manufacturing sector of nation currently accounts for 80% of the country's exports. Service sector is growing at alarming rate. It is contributing more than 50% in gross domestic product of country. Apart from that, economy of Pakistan has faced a lot of issues. The social indicators of Pakistan are among the worst in developing countries. Poverty is rising at alarming rate. Unemployment is another issue which government unable to overcome. Literacy rate of Pakistan is lowest among the South Asian countries. Corruption and political instability are the main causes for the current depraved condition of Pakistan. Despite these critical challenges, Pakistan has proved the no matter what happens and whatever challenges it may face, it will continue to survive.

The economic performance of Pakistan since the creation of Pakistan in 1947 is divided into eight phases to explain the performance clearly and in detail. Such eight phases of economic history are described as under.

2.2 1st phase – from independence to 1950

At its inception in 1947, Pakistan is the mainly agrarian economy – agriculture contributed to the Gross Domestic Product (GDP) in 1947 about 53% and contributed 53.2% in GDP from 1949 to 1950 [4]. At the time of the creation of Pakistan, Pakistan had a total population of 30 millions of which 6 million residents were living in urban regions. Furthermore, most of the workforce that is around 65% worked in the agricultural sector. Therefore, agriculture production contributing to the economy of Pakistan with 99.2% of exports and approximately 90% of Pakistan's foreign exchange income [4]. Pakistan is a minerally rich country. Mainly its natural resources include coal, natural gas, limestone, and marble reserves. However, the per capita income of Pakistani people in 1950 was $360 US dollars along with 10% of the literacy rate [13]. In addition to that, the poverty rate varies between 55% to 60% [11]. Considering, the capital shortage in the small private sector, the government of Pakistan depend on

the public sector for the development of economic-cum-industrial base in the country. Pakistan recorded a 2% of the national saving rate, a 4% of investment and a 2% saving rate in the year 1949-50. Nevertheless, the manufacturing sector contributed approximately 7.8% in GDP [15]. Whereas the service sector at that era contributed 39% to the economy of Pakistan. Lastly, in the Fiscal year 1949-50 to 1950-51, the trade deficit of Pakistan had about 66 million rupees [14].

2.3 2nd phase – 1950 to 1960

The decade of the 50s was known as the decade of planning in the economic history of Pakistan. In this decade, Pakistan launched first time its 5-years plan along with a three-year development plan. Pakistan strongly pursued the imports-substituting industrialization policy throughout this decade also. However, the public and private sector of Pakistan during the Korean war – which lasted from 1950 to 1953, developed rapidly on the enormous trader's profit. Resultantly, there was an acceleration in industrialization and industrial sectors developed into industrial capital. Because of this development, Pakistan became a member of the developing nations of the world in this era. Despite that, Pakistan economy was also dependent on foreign aid from United Stated. Pakistan received about $500 million US Dollars of the military as well as economic aid from 1955 to 1958 [14]. In addition to that, Pakistan also faced some issues in its agricultural sector. Due to shifting in the focus from agriculture to industrialization, the production of agriculture dropped from 2.6% in the fiscal year 1949-1950 – 1950-1951 up to 1.9% the in the fiscal year 1957-1958 – 1958-1959 [4].

	1949 - 1950	1954 -1955	1959 -1960
Agriculture	14,669 (60.0)	15,654 (56.1)	16,753 (53.3)
Industrial Manufacturing	1,433 (5.9)	2,220 (8.0)	2,930 (9.3)
Large Scale	346 (1.5)	1,002 (3.6)	1,565 (5.0)
Small Scale	1,087 (4.4)	1,218(4.4)	1,365 (4.3)
Other Sectors	8,364 (34.1)	10,034 (35.9)	11,756 (37.4)
Total GNP	24,466 (100)	27,908 (100)	31,439 (100)

Table 1: Gross National Product and shares of different sectors in GNP of Pakistan

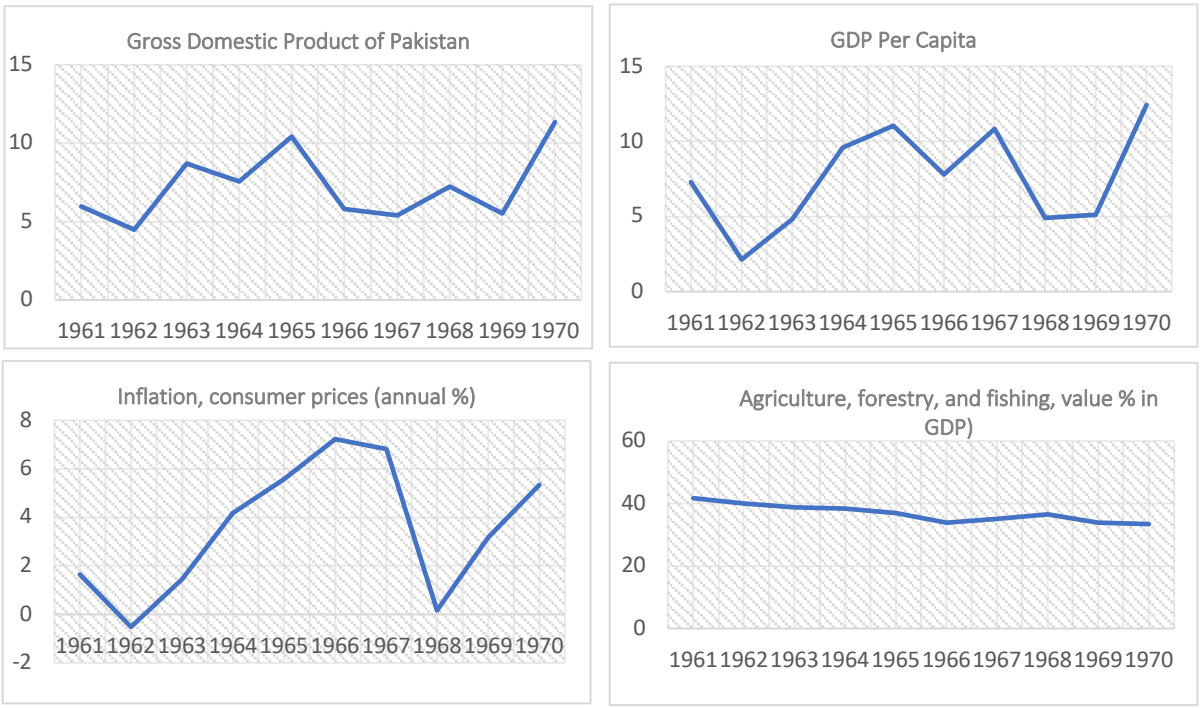
Data Source: focus-economics.com/countries/Pakistan

Unfortunately, during this decade, Pakistan experienced the martial law regime when General Ayub Khan – the Commander-in-Chief of the Pakistan Army the toppled democratic government by setting himself as President of Pakistan. This event distrusted the democratic process and prevented the nurturing of democracy in the roots of the political culture of Pakistan. Though, from the economic point of view, there were ups and downs in the economy of Pakistan. Balance of trade depreciated to -1043 million rupees from -831 million rupees during this year [14]. This happened due to the decline

of Pakistani goods exports to foreign countries up to 763 million rupees. Consequently, in the early 50s, there was growth in agricultural production at the rate of 1.6% per year and the manufacturing sector raised its production to 7.7% of average per annum [15].

2.4 3rd phase – 1960 to 1970

This decade was the glorious decade in the history of Pakistan. This happened due to political stability as well as the immense United States financial aid to Pakistan. This resulted in higher income, greater consumption of goods, rise in industrial and agricultural production. However, In the 60s, Pakistan's exports were greater than that of Asian countries including Thailand, Indonesia, Malaysia, and the Philippines. There were noteworthy investments in moderation of agricultural processes like improving water supplying methods, irrigation system and introduction of modern machines to framers. Fertilizer and pesticides along with high yielding seeds in the market were subsidized and introduced in the market to boost the agricultural product. In addition, Pakistan achieved about 16% growth per year in the manufacturing sector from 1960 to 1965. The growth was the result of protection was provided to the local industries from the imports of foreign goods to promote the local goods among the residents of Pakistan.



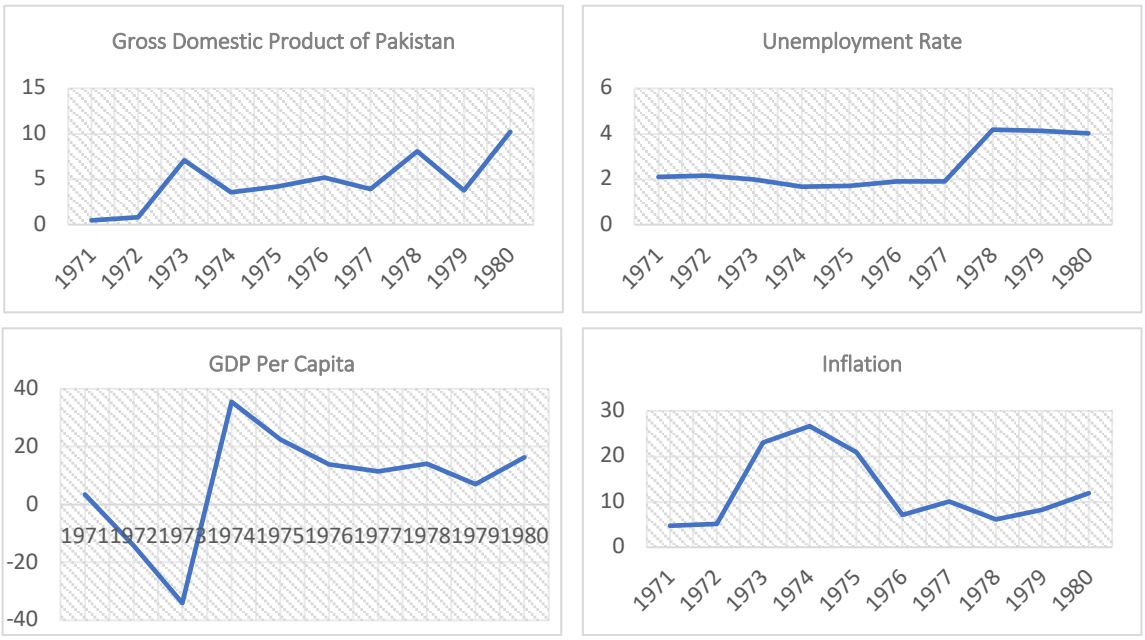
Graph 2: Macro-Indicators of Economic Performance of Pakistan in 1960s

Data Source: data.worldbank.org

In this glorious economic development decade, Pakistan waged the war with its neighbour India in 1965. War had immersive negative impacts not only on politics, economy but also had humanitarian impacts on Pakistan economy of Pakistan suffered a lot. There was a sharp decline in manufacturing production which grew at the lower rate of 10% to 1970 from 1965 [4]. In this decade, the growth of the Gross domestic product (GDP) of Pakistan recorded 6.7%. and Per capita gross national product was noted about 314 rupees in East-Pakistan and 504 rupees in West-Pakistan [14].

2.5 4th phase – 1970 to 1980

This decade proved to have an acidic impact on the history of Pakistan. Pakistan faced civil war among East Pakistan and West Pakistan. This revolt was the result of growing economic disparity among both regions of Pakistan. As a result, in 1971, East Pakistan became an independent state and separate country known as Bangladesh. Apart from that, the New political party became into power in this chaotic situation of the Country. Once again, Pakistan experienced a democratic ruling system in the country. Inspire of democracy in the country, the economy faced many issues. Pakistan faced a sharp rise in inflation along with an increased poverty index up to 55% in 1972 [11]. The prices raised 15% per annum. Not only Pakistan the world also faced economic issues due to oil price shocks. However, Gross domestic product development in the Prime Minister Zulfiqar Ali Bhutto time frame, albeit 4.9% every year, was the assault of massive floods in Pakistan and poor harvests adversely affected agricultural growth. Pakistan experienced floods in years which are 1974, 1973, 1976 and 1977. Pakistan also confronted a trade balance deficit in this decade. The trade deficit increased to 1184



Graph 3: Macro-Indicators of Economic Performance of Pakistan in 1970s

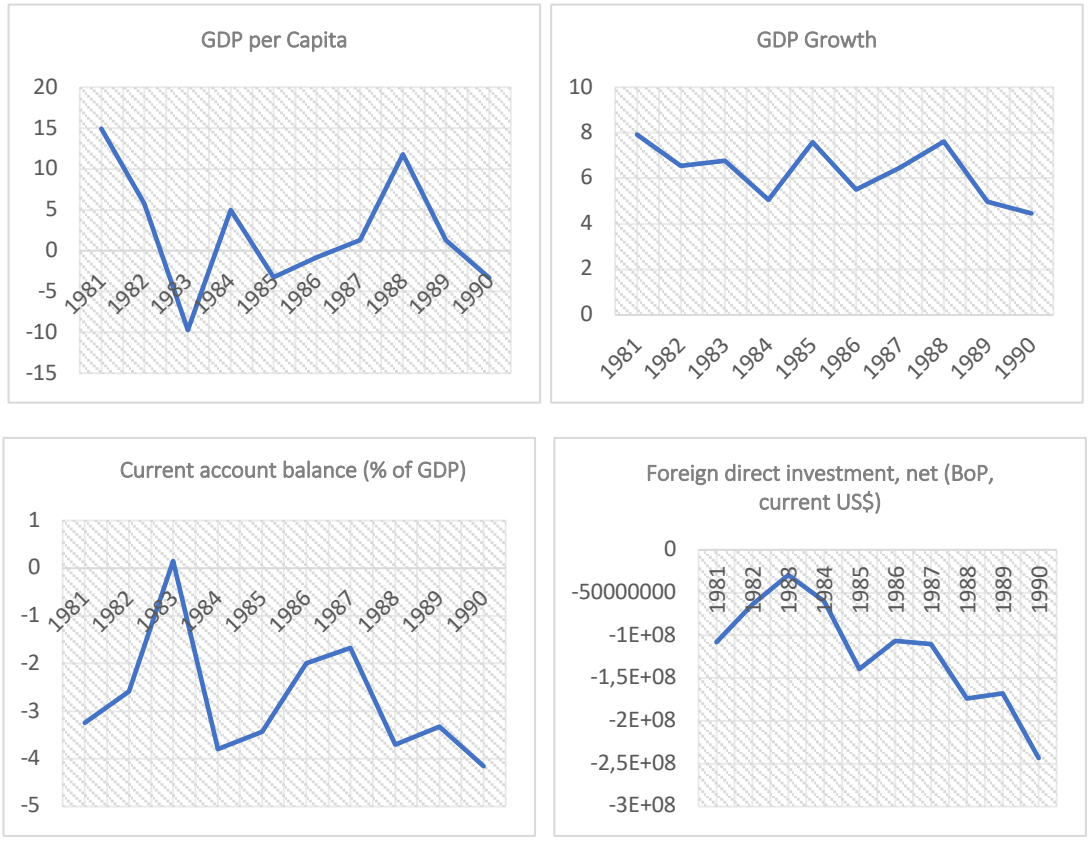
Data Source: data.worldbank.org

million US dollars from 337 US dollars; however, the fiscal deficit of Pakistan ratio was 8.1% from 1971 to 1997 [14].

Unfortunately, even during this decade, Pakistan faced a martial law regime. A military coup d'état occurred on 5 July 1977 in Pakistan when General Muhammad Zia-ul-Haq toppled the government of Pakistan People's Party. General Zia regime perused the policies of denationalization, deregulation, and privatization in the country. Even in this worst ear of the economic history of Pakistan, the agriculture and manufacture sector grew to 2.4% and respectively to 5.5% per annum [15]. Although large and medium-sized manufacturing accounted for 75% of value-added and 70% - 80% of overall manufacturing investment in the 1970s; however, small-scale manufacturing accounted for the remaining 25% value-added [16].

2.6 5th phase – 1980 to 1990

This phase of the economic history of Pakistan is particularly known for the growth of the private sector and immersive investment in the industrial sector. Conversely, the 1970s was the era of



Graph 4: Macro-Indicators of Economic Performance of Pakistan in 1980s

Data Source: data.worldbank.org

nationalization in Pakistan. Major investments in the industrial sector in the private sector caused higher growth in industrial production which helped in the decline of Poverty in Pakistan up to 29.10% in the fiscal year 1987 along with declination in the unemployment rate to 2.6% in 1990 from 3.7% in 1980 [16].

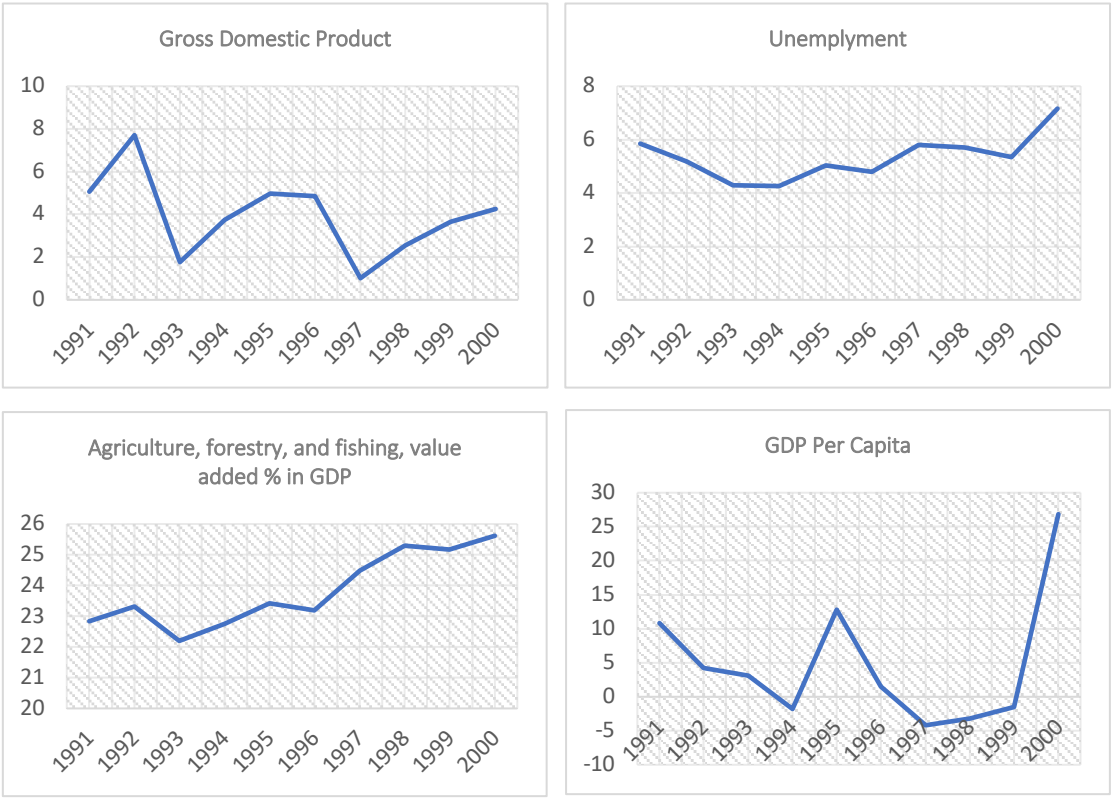
There was another interesting development that happened in Pakistan in the year 1985 to 1988 that was the creation of an Islamic banking system in the country to introduce an Interest-free banking environment in the banking sector of the nation accompanied by an Islamic partnership system of profits and losses sharing method. In addition, Pakistan completed another target of 16% of the national savings per GDP ratio in 1987 [11]. This achievement was due to the massive inflow of money sent by the Pakistan workers in foreign countries especially from the Middle Eastern countries. Besides that, Pakistan faced the issue of negative public savings and deteriorating public investment per GDP ratio throughout the decade of 1980s and used an outsized portion of extra-national savings to finance the fiscal deficits of the country. However, the gradually increasing massive budget deficits in the early 80s were financed through non-banking domestic borrowing methods. As a result of that up to 1988, the domestic debt raised to 5.21 billion rupees [18]. Therefore, the public debt/ GDP ratio was 77.1% in 1988, 81.9% in 1989 and 82.6% in 1990 [17]. The consequences of the public debt have defected in the country in the form of higher interest payments, higher public expenditure and widening of fiscal deficit. However, the Democratic system once again was reinstated in the country in 1985. Through this phase, the average GDP growth rate was recorded up to 6.3% [14].

2.7 6th phase – 1990 to 2000

During the 1990s, Pakistan faced the issues of decreasing workers remittances and rising external deficit. Within the wake of decreasing growth rates of GDP, the second-worst inflation occurred in the country. Additionally, the unemployment rate raised from 5.9% to 7.2% from 1990 to 2000 [4]. Pakistan backed enlarged accounting deficits through increasing residents' foreign currency deposits. External debt reached a new limit and amounted to 30 billion US dollars in the 1990s [4]. The external debt tripled from 1980 to 1995. Consequently, the external debt/GDP ratio reached to 50% from 42% and external debt/exports ratio reached to 258% from 209% [18]. By the late 90s, Pakistan was experiencing a critical state of paralysis and economic stagnation. International Monetary Fund's programs as well as the International Bank for Reconstruction and development programs had been suspended. Additionally, bilateral donors sacked aid to Pakistan. As a result, that, Pakistan was at the brink of default on its external payments. Because of the brink condition of Pakistan's external liabilities, Pakistan backed the external liabilities with domestic borrowing. Resultantly, the domestic

debt rose to 909 billion rupees and the domestic debt to GDP ratio reached 42% [4]. After a relatively peaceful decade but an economically motionless era, in 1999, General Pervez Musharraf carried a bloodless military coup in Pakistan by tumbling the democratic government of Prime Minister Nawab Sharif. The Musharraf led government accelerated economic growth by doubling the gross domestic product along with exemplary growth in the Middle-class section of Pakistan.

In 1999, The total debt percentage of the GDP of Pakistan reached 99.3% of its GDP and 629% of its revenue receipts, it reached to top in South Asia, as compared to Sri Lanka - 91.1% & 528.3% and India - 47.2% and 384.9% respectively [16]. Internal Debt of Pakistan reached to 45.6% of GDP and 289.1% of its revenue receipts, as compared to Sri Lanka - 45.7% and 264.8% and India - 44.0% & 358.4% respectively [16].



Graph 5: Macro-Indicators of Economic Performance of Pakistan in 1990s

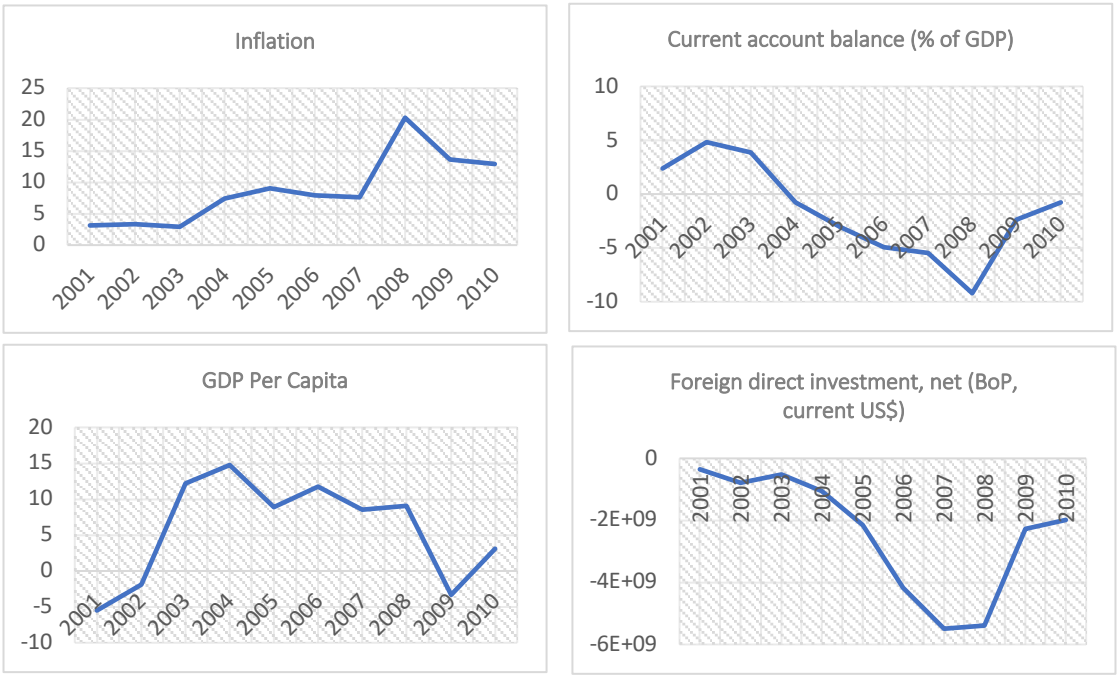
Data Source: data.worldbank.org

2.8 7th phase – 2000 to 2010

In 2001, the Official Debt and Management Reduction Committee found the public debt as a major cause of lower growth rate at less than 4% per year. However, the 1990s' debt crisis was followed in the 2000s by the macroeconomic crisis-era; despite a positive growth rate till 2005. The poverty rate floated in this decade in Pakistan. It was reached 34.5% in 2000 and reduced to 22.3% in 2006 [11]. So

was the case with the unemployment in the country. It reduced to 5% in 2008 from 7.8% in 2002 [4]. In 2009, the Literacy rate was climbed to 55% [20]. As far as inflation is concerned, it recorded in 2009 about 4.1% [13]. In addition to that, the agricultural growth was noted as 2% along with 4.9% of industrial growth. However, Public debt reached 8,160 million rupees in 2010 with public debt to GDP ratio of about 56% [15].

Pakistan was ranked fourth in the fastest-growing economies of the Asian region from 2000-2007 with an average growth of 7.0% per annum [20]. Because of greater economic growth, Pakistan effectively reduced the poverty rate by one and a half, provided about 13 million opportunities of jobs for a young generation of Pakistan, improved foreign exchange reserves to a suitable amount and restored the investors' confidence to invest in the country [18]. The aim behind all the positive indicators was to become an independent state in order not to depend on the International Monetary Fund and to become a self-sufficient state.



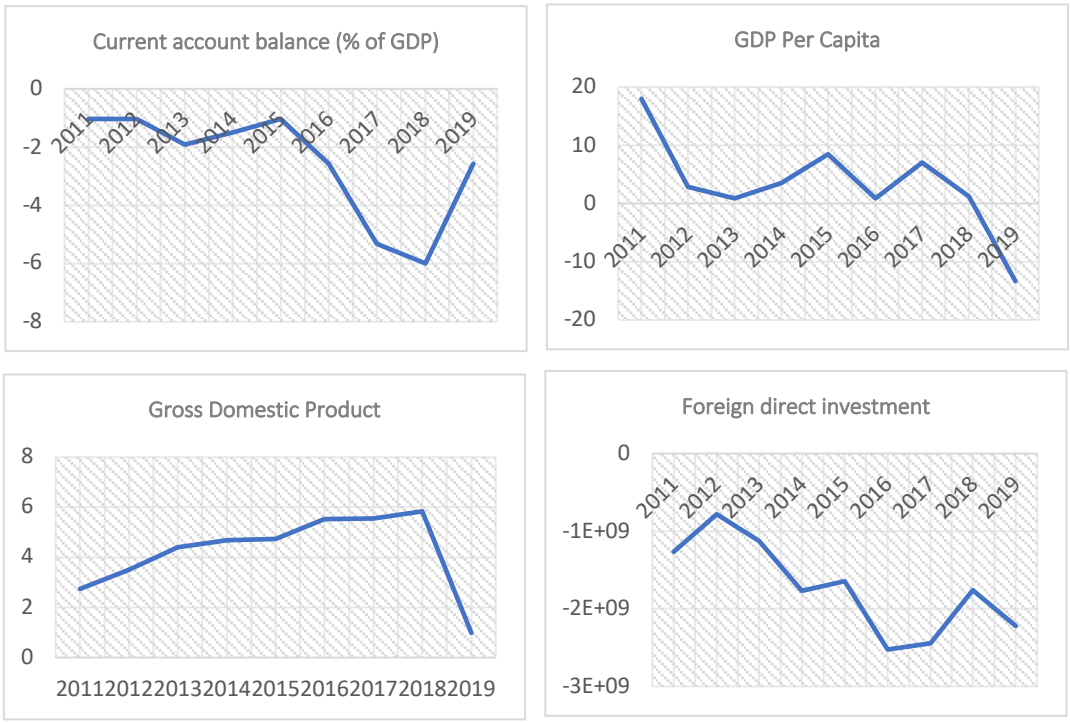
Graph 6: Macro-Indicators of Economic Performance of Pakistan in 2000s

Data Source: data.worldbank.org

2.9 8th phase – from 2010 to till-to-date

This phase has mixed impacts on the economy of Pakistan. The most important event which caused trouble to the economy not only of Pakistan but also of all developed and developing economies of the world was the 9/11 attack on World Trade Centre by Osman-bin-laden. This event shocked the

world. Aftershocks of attack shaken the peace and hindered the progress of South Asian countries. Before happening of 9/11, Pakistan was hit by the worst floods all over the regions of the country. Floods caused damage of about 40 billion dollars to the infrastructure of the nation. Despite that, gradual growth in Pakistan's GDP in 2012 started and it was reached 5.3% in 2017 [4]. Additionally, in 2017, the unemployment rate was recorded up to 6% [11]. In 2013, Pakistan with International Monetary Fund signed a deal of 6.3 billion dollars to back the public finances, current account deficit and to cover the shortage of energy all over the country [18]. The year 2013 proved lucky for the economy of Pakistan because China-Pakistan Economic Corridor was formalized. Originally the project value was estimated at 47 billion dollars [20]. However, the Economic Corridor was formalized by the Signing of 52 memorandums of understanding during the Chinese Premier's Visit to Pakistan in May 2013.



Graph 7: Macro-Indicators of Economic Performance of Pakistan in 2010s

Data Source: data.worldbank.org

Another ground-breaking event occurred which boosted the economy of Pakistan was the introduction of a modern and fast cellular internet connectivity system in the country. The 3G and 4G cellular internet connectivity services launched in 2014. Licenses of 3G and 4G was auctioned. The process of the auction provided 1.1 billion dollars to Pakistan by allowing cellular companies to provide modern connectivity services to network users [20]. These events paved to way for the restoration of macroeconomic stability in the country improved its credit rating and helped in achieving higher

growth. The Pakistani rupee has remained relatively stable against the US dollar since 2015, though it declined about 10% between 2017 to 2018 [11]. Balance of payments concerns has re-emerged, however, because of a significant increase in imports and weak export and remittance growth. In 2018 it recorded a growth of 5.80% as compared to the growth of 5.43% last year [20]. Manufacturing is the most vibrant subsection of the industrial sector having 64.8% contribution in the industrial sector and GDP accounts for 13.6% [4].

Chapter Three

Current Economic Outlook of Pakistan

3 Chapter III: Current Economic outlook of Pakistan

3.1 Overview of current Economic Outlook

Pakistan has accomplished consistent development since 2013. Before that, Pakistan had inconsistent growth throughout history. Further, the monetary development of Pakistan was assessed to have tumbled to 3.3% in 2019 from 5.5% every year sooner and 0.7 rates. This was essential because the economists have taken to counter macroeconomic improper and un-stabilized growth. Economic growth is required to ease back further to - 1.5% in 2020 because of the episode of the COVID-19 and get to 2% in 2021, as per the refreshed IMF conjectures [11]. The beginning of 2019 was noted due to the falling of Pakistan's foreign reserves which were holding beneath the USD 7 billion. That were causing troubles to the nation’s capacity to respect its monetary commitments. The foreign reserves of Pakistan mainly depend upon the remittances send by Pakistani workers work in the United Arab Emirates and Saudi Arabia. They provide great help to decreasing the further falling of foreign reserves. Due to the deterioration of the economic condition and to keep the economy continue to achieve economic growth, the IMF endorsed two new tranches of advance under the Extended Fund Facility first in July 2019 and another in February 2020. As indicated by information from the State Bank of Pakistan, Foreign currency exchanges reserves went to USD 18 billion in March 2020 [4]. The State Bank likewise said the nation may not require in future any help from global financing institutions if the growth continues later in 2020. Despite that, government debt continues to increase. It has reached 76.7% of GDP in 2019, against 71.7% of respective years. But the global financial institution like IMF anticipates minor debt variances. IMF has forecasted the debt ratio to GDP will go down to 76.1% in 2021 from 78.6% in 2020. It will be the result of lower imports that leads the current shortfall down to 5% in 2019 and will continue to fall further to 2.4% by 2021 [22].

While the poverty rate has fallen dramatically since the beginning of the 1990s, the recent estimates from the Department of Planning for Growth and Reform indicate that 29.5% of the population of the country lives below the poverty line [16]. In 2019, the unemployment rate was 4.1%, relative to 5.6% in 2018, but the degree of underemployment appears to be extremely high and most of the economy is informal. Despite the negative economic effects of the COVID-19 epidemic, the IMF projects the unemployment rate to stay unchanged over the next two years, with the rate expected to hit 4.5% in 2020 and 5.1% in 2021 [20].

	2015-16	2016-17	2017-18	2018-19	2019-20
Population (million)	190	194	197	201	205
GDP per capita (USD)	1.426	1.440	1.545	1.566	1.360
GDP (USD bn)	271	279	305	315	278
Economic Growth (GDP, annual variation in %)	4,7	5,5	5,6	5,8	1
Consumption (annual variation in %)	2,9	7,6	8,5	6,2	3
Investment (annual variation in %)	15,8	7,5	10,3	11,2	-12,8
Industrial Production (annual variation in %)	5,2	5,7	4,6	4,6	-2,3
Unemployment Rate	5,9	6	6	5,7	-
Fiscal Balance (% of GDP)	-5,3	-4,6	-5,8	-6,6	-8,9
Public Debt (% of GDP)	61,8	65,5	65,1	69,9	83,7
Money (annual variation in %)	12,8	14,5	13,9	9,5	10,8
Inflation Rate (CPI, annual variation in %, eop)	3,2	3,7	5,4	5,4	12,7
Inflation Rate (CPI, annual variation in %)	2,5	3,8	4,3	5,3	9,4
Policy Interest Rate (%)	6,5	5,75	5,75	6,5	12,25
Exchange Rate (vs USD)	104,9	104,4	110,7	139,8	155
Exchange Rate (vs USD, aop)	102,8	104,7	105,3	121,7	150,4
Current Account (% of GDP)	-1	-1,7	-4,1	-6,3	-4,9
Current Account Balance (USD bn)	-2,8	-4,9	-12,6	-19,9	-13,5
Trade Balance (USD billion)	-17,3	-19,1	-26	-30,9	-27,6
Exports (USD billion)	24,1	22	22	24,8	24,3
Imports (USD billion)	41,4	41,1	48	55,7	51,9
Exports (annual variation in %)	-3,9	-8,8	0,2	12,6	-2,1
Imports (annual variation in %)	-0,8	-0,6	16,7	16	-6,8
International Reserves (USD)	16	20,9	18,7	12,4	10,2
External Debt (% of GDP)	24,1	26,5	27,4	30,3	38,2

Table 2: Economic Data of Pakistan of past 5 years

Data Source: Pakistan Bureau of Statistics

3.2 Growth and Investment

The tentative Gross Domestic Product (GDP) growth rate for the fiscal year 2020 is projected to be negative at 0.38%, macroeconomic stability steps were taken by the government over the past year have led to a substantial narrowing in the Saving-Investment Deficit, driven primarily by a decline in the trade deficit and a rise in the remittances of workers. It is indeed worth noting that during the first three quarters of the fiscal year 2020, the fiscal deficit remained confined. Traditionally, private demand has made significant contributions to the economic development of Pakistan. The trend was likely to persist, but, thanks to COVID-19, private consumption suffered greatly. It fell to 78.5% in FY-2020 as a percentage of GDP, compared to 82.9% in FY-2019 [20]. As a percentage of GDP, private investment fell to 9.98% against 10.29% in FY2019 while public investment (including investment by the general government) displayed progress since it stood 3.8% from 3.7% last year [12]. Throughout FY-2020, however, there had been a 13.2% increase in public spending (including investment by the General Government), although last year it fell by 21.6% [11].

Unlike other countries, the economy of Pakistan has a unique architecture, with three major sectors which are contributing to its economy that are agriculture, manufacturing, and services. However, as we know the economy of Pakistan supported three sectors. Its agriculture sector has experienced a growth of 2.67% in the current year [20]. The crop sector had seen a good rise of 2.98% during FY-2020, predominantly resulting in the positive development of 2.90% in essential crops [20].

The final quarter was projected by the Pakistan Bureau of Statistics (PBS), considering the lockdown situation faced by the industrial sector due to COVID-19. According to that report of PBS, the manufacturing sector-major effects, especially of large-scale manufacturing and small-scale manufacturing sectors, which they are experiencing had been observed. However, Provisional industrial sector production performance was projected with a negative growth of 2.64%, primarily due to the adverse -8.82% rise in the mining and quarrying sector and a 7.78% fall in the large-scale manufacturing sector [11]. Besides, The Small-Scale Industry's growth forecasts for FY-2020 are 1.52% because of the lockdown crisis in the region.

Because of the country's lock-down situation due to Covid-19, like that of the manufacturing sector, the economic services industry seems to have had a considerable effect, notably in the wholesale and retail trade and transport sectors. The services sector has tentatively dropped to 0.59%, primarily leading to a decrease of 3.42% in the retail and wholesale trading sector and a decrease of 7.13% in the shipping, storage, and communication industries [12]. In addition to that, a small rise of 0.79 %

was seen in the finance and insurance industries. At 4.02%, 3.92% and 5.39% respectively Housing Facilities, General Social Programs and Other Private Services progress was noted [22].

In a total of 190 economies, Pakistan clinched 108th position. During July-March FY-2020, when foreign direct investment rose by 137.3% and hit $2.1 billion against $0.9 billion last year, that helps bring international investors to Pakistan [23]. In addition to focusing on "ease of doing business" to draw more future FDI, the government aims to further strengthen the policies to create a favourable climate for further encouragement of foreign investment in the country.

On the fiscal front, all the main fiscal metrics shifted radically, and the development lasted until March 2020, indicating that fiscal expansion was on track. The fiscal deficit decreased to 4.0% of GDP between July-March, FY2020, to a deficit of 5.1% in the same timeframe of FY-2019 [11]. A noteworthy increase was noted during July-March, FY2020 in the primary balance as it reported a gain of Rs 193.5 billion from the shortfall of Rs 463.3 billion last year [23]. The rise in output is mainly ascribed to dramatic growth in provincial surplus and non-tax collections. On the contrary, while the FBR income tax stayed lower than the anticipated amount. But, from July-March FY2020, an increase in the tax collection amount was noted to 13.3% relative to last year [20]. The FBR's fewer recovery of taxes is also contestable because it was primarily due to a substantial deterioration of imports, thereby reducing the accumulation of import taxes and other taxes by a significant amount at the import level.

	2015-16	2016-17	2017-18	2018-19	2019-20
As percent of GDP (mp)			F	R	P
Total Consumption	91.3	93.2	93.8	94.6	91.6
Private Consumption Expenditure	80.3	81.9	82.9	82.9	78.5
General Government Expenditure	11.3	11.3	11.7	11.7	13.1
Total Investment	15.7	16.2	17.3	15.6	15.4
Gross Fixed Capital Formation	14.1	14.6	15.7	14.0	13.8
Private	10.3	10.1	10.5	10.3	10.8
Public including General Public	3.8	4.5	5.2	3.7	3.8
Change in Inventories	1.6	1.6	1.6	1.6	1.6
National Saving	13.9	12.0	11.3	10.8	13.9
Domestic Saving	7.8	6.5	5.9	4.1	6.8
Foreign Saving	1.7	4.1	6.1	4.8	1.5

Table 3: Savings and Investments as a percentage of GDP

Data Source: Economic Survey of Pakistan

Flows (Point Contribution)	2015-16	2016-17	2017-18 F	2018-19 R	2019-20 P
Private Consumption	5.01	9.91	7.05	8.84	3.43
Public Consumption	1.01	1.07	1.43	1.16	2.69
Total Consumption [C]	6.02	10.98	8.48	10.00	6.12
Gross Fixed Investment	0.82	1.89	2.52	-0.37	1.16
Private Investment	0.56	0.73	1.38	0.75	0.67
Public Investment	0.26	1.15	1.14	-1.12	0.49
Changes in Stock	0.10	0.16	0.14	0.16	0.16
Total Investment [I]	0.91	2.05	2.66	-0.22	1.32
Exports (Goods & Services) [X]	-0.91	-0.08	1.47	2.13	0.41
Imports (Goods & Services) [M]	0.07	3.16	4.17	2.22	-2.04
Net Exports [X-M]	-0.99	-3.24	-2.70	-0.09	2.45
Aggregate Demand [C + I + X]	6.02	12.95	12.61	11.91	7.85
Domestic Demand [C + I]	6.94	13.03	11.14	9.78	7.44
GDP (mp)	5.95	9.79	8.44	9.69	9.89

Table 4: Point Contribution of Determinants to GDP Growth

Data Source: Pakistan Bureau of Statistics

	2015-16	2016-17	2017-18	2018-19	2019-20
A. AGRICULTURE	0.03	0.43	0.77	0.11	0.50
B. INDUSTRIAL SECTOR	1.18	0.95	0.96	-0.47	-0.52
COMMODITY PRODUCING SECTOR (A+B)	1.21	1.38	1.73	-0.36	-0.02
C. SERVICES SECTOR	3.35	3.83	3.81	2.27	-0.36
GDP (fc)	4.56	5.22	5.53	1.91	-0.38

Table 5: Sectoral Point Contribution in GDP

Data Source: State Bank of Pakistan

3.3 Fiscal Development

Fiscal policy has a crucial part to play in maintaining an efficient allocation of capital and income in the community. In short, improved fiscal management allows to maximize household savings and boost the quality of the deployment of wealth. As a result, it lays the groundwork for macroeconomic stability to be achieved concurrently encouraging more balanced and equitable development.

Traditionally, as Pakistan's economy is experiencing greater growth, this did not produce any longer positive impact on the economy because of the occurrence of macroeconomic imbalances. As compared to the investment, growth was primarily guided by consumption-led expenditure. Higher external and fiscal imbalances have been created by the non-productive nature of this development. As a result, the expectations for development have been severely weakened. In addition, the situation was further aggravated by systemic deficiencies such as poor tax administration, a tough economic

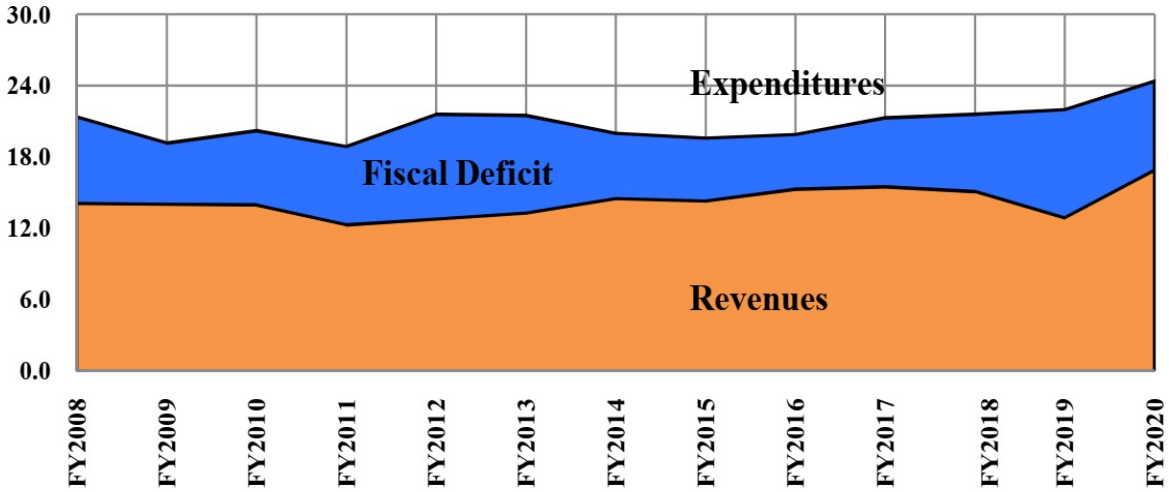
climate, a low tax-to-GDP ratio, and inadequate funding. The economy had been at a pivotal moment in 2018 because of increasing debt and liabilities, high current deficit and fiscal deficit, reduction of foreign currency reserves. Persistently larger fiscal gaps related to income disparity which led to high levels of public borrowing have been the primary driver of macroeconomic imbalances. The government has developed reforms and demand management strategies to ensure sustainable economic development and to boost opportunities for growth in the wake of these challenges. To finance such governmental reforms program, Pakistan stepped into a 39-month Extended Fund Facility with the IMF for $6.0 billion [12].

These policies have enabled the government to control macroeconomic inequalities by introducing fiscal limits on fiscal restraint and fiscal contraction. In the first nine months of the financial year, all major fiscal variables were significantly boosted because of the government's strict fiscal policy to increase revenues by extensive tax and administrative reforms, along with the rationalization of spending. To ensure debt sustainability over the longer run, the effectiveness of these policies will then be beneficial in overcoming a significant primary deficit. In addition, financial control is being improved with the implementation of the Public Finance Management Act 2019 and it will promote fiscal discipline and accountability and move forward

The success of fiscal metrics shows that fiscal reform has been on a better course within the first nine months of the financial year. In addition to that, the total fiscal deficit has lowered to 4.0% of GDP compared to 5.1% of GDP reported in the same span of the previous year, while, in July-March FY-2020, the primary balance has a surplus of Rs 194 billion against a deficit of Rs 463 billion in the comparable period of FY-2019 [20]. In between July-March FY2020, overall revenues increased to 30.9% over 0.04 % in the same timeframe of FY-2019 due to a huge improvement in both tax and non-tax revenues. Comparably, PSDP spending on the cost side had seen significant improvement mostly at the federal and provincial scales. However, between July-March FY-2020, total PSDP spending has increased by 24.9% relative to the previous year [11].

The Coronavirus breakout (COVID-19) has, nevertheless, adversely influenced the near-term perspective. Squeezing the fiscal progress made during the current financial period has posed major difficulties for the economy. Fiscal accounts are expected to come under immense scrutiny, in particular, because of such conditions. On the other hand, the Government aims to mitigate the effect of COVID-19 on the economy by concentrating on rising spending on public welfare and improving social safety net programs. Therefore, by doing so, the budget would momentarily deviate from the original targets. On the revenue side, the accomplishment of both tax and non-tax goals will be daunting due to the disruption in economic development, illustrated by both supply and demand

disturbances. Additionally, to minimize the adverse impact of COVID-19, the government has behaved in a prompt and very well approach. Appropriate efforts have been made to boost the economy through monetary and fiscal policies. A robust fiscal stimulus program is already unveiled on the fiscal side to cover the expenditure intended to buffer the impact of the COVID-19 impact. The program had produced a strain on fiscal payments, but the effect may have become critical if the pandemic lasts much longer. In addition, the State Bank of Pakistan behaved promptly with a fitting monetary policy response. The initiatives are aimed at reducing the policy rate and adopting numerous opportunities to expand the liquidity of, in specific, small-scale enterprises. In the aftermath of the COVID-19 crisis, numerous several temporary and time-bound measures have been introduced to ensure fiscal stability and the functioning of the financial system.



Graph 8: Revenue-Expenditure Gap (% of GDP)

Graph Source: Pakistan Economic Survey 2019-20

Year	Total Expenditure	Current Expenditure	Mark-up Payments	Defence	Devlopment Expenditure	Non Interest non-Defence Exp	Fiscal Deficit	Revenue Balance	Primary Balance
2006	17.1	12.6	2.9	2.9	4.4	11.2	4.0	0.5	-1.1
2007	18.1	14.9	4.0	2.7	4.7	11.4	4.1	-0.8	-0.1
2008	21.4	17.4	4.6	2.6	4.2	14.2	7.3	-3.3	-2.7
2009	19.2	15.5	4.8	2.5	3.4	11.8	5.2	-1.4	-0.3
2010	20.2	16.0	4.3	2.5	4.1	13.4	6.2	-2.1	-1.9
2011	18.9	15.9	3.8	2.5	2.8	12.6	6.5	-3.5	-2.7
2012	21.6	17.3	4.4	2.5	3.9	14.6	8.8	-4.5	-4.3
2013	21.5	16.4	4.4	2.4	3.5	14.7	8.2	-3.0	-3.8
2014	20.0	15.9	4.6	2.5	4.5	12.9	5.5	-1.5	-1.0
2015	19.6	16.1	4.8	2.5	4.1	12.3	5.3	-1.8	-0.6
2016	19.9	16.1	4.3	2.6	4.5	13.0	4.6	-0.9	-0.3
2017	21.3	16.3	4.2	2.8	5.3	14.3	5.8	-0.8	-1.6

2018	21.6	16.9	4.3	3.0	4.6	14.3	6.5	-1.8	-2.2
2019	22.0	18.7	5.5	3.0	3.1	13.5	9.1	-5.8	-3.6
2020	24.4	20.5	6.6	2.6	4.0	15.2	7.5	-3.6	-0.9

Table 6: Trends in Components of Expenditure (As % of GDP)

Data Source: Pakistan Bureau of Statistics

	FY2020 B. E	**July-March (Rs Billion)**		**Growth**
		FY2020	FY2019	FY2020
A. Total Revenue	7,458.0	4,689.9	3,583.7	30.9
% Of GDP	16.9	11.2	9.4	
a) Tax Revenue	6,431.0	3,594.3	3,162.1	13.7
% Of GDP	14.6	8.6	8.3	
Federal	5,822.0	3,273.1	2,874.4	13.9
of which FBR Revenues	5,555.0	3,044.3	2,704.5	12.6
other Federal	267.0	228.8	169.9	34.7
Provincial Tax Revenue	609.0	321.2	287.7	11.6
b) Non-Tax Revenue	1,027.0	1,095.6	421.6	159.9
% Of GDP	2.3	2.6	1.1	
B. Total Expenditure	10,740.0	6,376.1	5,506.2	15.8
% of GDP	24.4	15.3	14.5	
a) Current Expenditure	9,025.0	5,611.6	4,798.4	16.9
% of GDP	20.5	13.4	12.6	
Federal	6,096.0	3,887.7	3,180.9	22.2
Mark-up Payments	2,891.0	1,879.7	1,459.2	28.8
% Of GDP	6.6	4.5	3.8	
Defence	1,153.0	802.4	774.7	3.6
% Of GDP	2.6	1.9	2.0	
Provincial	2,929.0	1,723.9	1,617.4	6.6
b) Development Expenditure & net lending	1,715.0	781.4	684.2	14.2
% Of GDP	3.9	1.9	1.8	
PSDP	1,662.0	722.5	578.5	24.9
Other Development	80.0	29.2	77.4	-62.2
c) Net Lending	-27.0	29.7	28.3	4.9
e) Statistical discrepancy	0.0	-16.9	23.7	
C. Overall Fiscal Deficit	-3,282.0	-1,686.2	-1,922.5	-12.3
As % of GDP	-7.5	-4.0*	-5.1**	
Financing of Fiscal Deficit	3,282.0	1,686.2	1,922.5	-12.3
i) External Sources	1,829.0	682.4	524.5	30.1
ii) Domestic	1,453.0	1,003.8	1,398.0	-28.2
- Bank	484.0	601.8	787.7	-23.6
- Non-Bank	819.0	402.0	610.4	-34.1
Privatization Proceeds	150.0	0.0	0.0	
GDP at Market Prices	44,003	41,727	37,972	9.9

*On the basis of provisional GDP
**On the basis of revised GDP

Table 7: Consolidated Revenue & Expenditure of the Government

Data Source: State Bank of Pakistan

3.4 Inflation

Better growth and productivity results are often correlated with low inflation. In addition to reducing instability, market stability has multi-dimensional favourable effects on the social, economic, and psychological domains of all sectors of society, particularly poor households. The government made efforts to stabilize the inflationary pressure that resulted from the necessary reform policies before the COVID-19 epidemic. Thus, the inflation boosts which emerged because of energy tariff adjustments and market-based exchange rate acceptance was flattened largely as a result of government price stabilization policies. Therefore, by the end of the current fiscal year, the annual Consumer Price Index (CPI) inflation is projected to slow down. Demand and Supply around the world have been influenced by the advent of COVID-19 and psychological distancing techniques to manage this pandemic. To monitor inflation, the State Bank of Pakistan (SBP) has kept a double-digit rate of interest and has decided to cut the political rate sharply by 525 basis points to 8% [24]. The reduction in the policy rate is intended to promote economic growth following COVID-19 in the face of a decline in inflation.

Inflationary tensions continued throughout the first seven months of the new fiscal year. In January 2020, the rate of inflation increased to 14.6% from 5.6% the same month last year, largely because of a steep rise in food inflation [24]. This pattern was due to many reasons, along with sudden supply shortages and elevated cost of transport. One other factor is the shift in climatic conditions, which has caused losses on minor crops across all 2019 seasons and increased dependence on imported food.

The Government has taken a mix of policy steps to maintain market stability, such as curbing current expenses, maximize farming production, boost demand to stimulate production and ensure that consumer products are available adequately. The government had been cautious concerning the smooth retail delivery of goods. The government offered a large subsidy to the Service Stores Company named Utility Stores Corporation (USC) to help the common people. Basic commodities like wheat flour, sugar, pulses, and cooking oil were then sold by Utility Stores to consumers at subsidized rates. Most of these measures assisted in the reduction of single-digit CPI-national, which in April 2020 dropped to 8.5% [25]. That was the third straight month that saw the continuous falling of inflation, although in the last three months it declined by more than 6%. The outbreak of COVID-19 has

adversely impacted the global economy, especially regular wagers, and needy people. To fight this pandemic, the administration has prepared accordingly and is using all required resources successfully, thereby doing better than many financially prosperous nations.

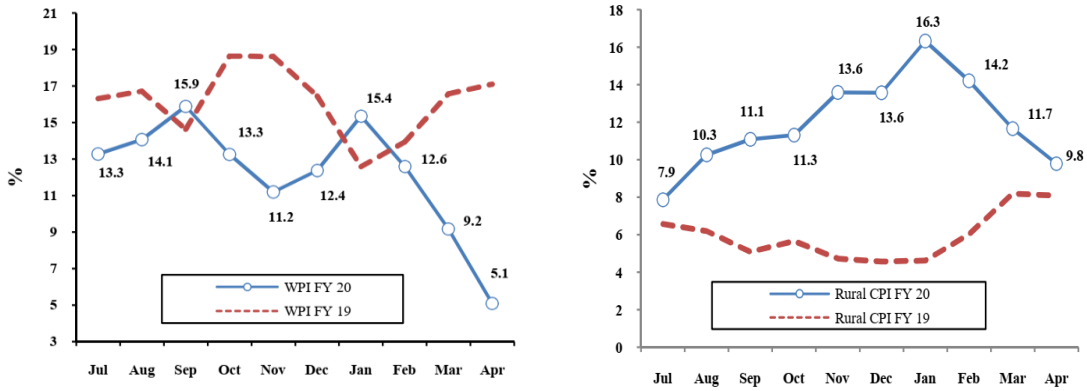
The government of Pakistan has unveiled a roughly Rs 1.24 trillion economic relief and stimulus package, the largest ever in the history of Pakistan, to benefit the vulnerable and enable the local economy to offset the negative effects of the country's coronavirus epidemic. Most notably, on May 1, 2020, the government lowered the prices of different petrochemical products ranging from Rs 15 to Rs 30 to further ease the economic issues of people [24]. Originally, the petroleum product prices lowered in March by up to Rs 7 per litre, and in April by Rs 15 per litre [20]. As is evident from the April results, the decrease in petroleum products prices in March and April, helped in further slowing the inflation rate.

In July-Apr 2020, the inflation rate was 11.22% compared to 6.51% in the same timeframe last year, as calculated by CPI. Perishable foodstuffs are the significant components to food inflation in the Food and Non-Alcoholic Drinks Category, as reported at 34.7% compared to 7.1% at the same time. Non-perishable food item inflation is estimated at 12.4% from 5.5% as of last year [25]. The Substantial rise in the Federal Excise Duty (FED) resulted in the consumption of nicotine has raised the burden on Alcoholic Beverage & Tobacco by 21.9% during the same period last year, as compared to 10.7% during July-April FY-2020 [20]. In July-April FY-2020, domestic, water, coal, and other fuels accounted for 7.1% compared to 8.2% at the same time last year. It weighs 23.6%, so any adverse movement impacts the vulnerable section of society directly [24]. The key parties are responsible for CPI movements are given as under

Commodity	Weights	% On Average Basis	
		Jul-Apr 2018-19	Jul-Apr 2019-20
General (WPI)	100.0	16.2	12.2
Agriculture Forestry & Fishery Products	25.8	9.5	11.4
Ores & Minerals, electricity, gas & water	12.0	25.3	30.1
Food Products, Beverages & Tobacco, Textiles, Apparel & Leather Products	31.1	10.1	10.6
Food Products and Bev. & Tobacco	20.1	7.3	12.9
Textiles & Apparel	10.3	15.5	7.3
Leather Products	0.7	6.3	5.0
Other Transportable Goods Except Metal Products, Machinery& Equipment's	22.4	30.0	5.5
Metal Products, Machinery & Equipment	8.7	9.0	13.9

Table 8: Wholesale Price Index (WPI)

Data Source: Pakistan Bureau of Statistics



Graph 9: Year wise Urban and Rural CP Inflation

Graph Source: Pakistan Economic Survey 2019-20

Commodity	Weights	% Change On Average Basis	
		2018-19(Jul-Apr)	2019-20(Jul-Apr)
CPI National	100.0	6.5	11.2
Food & Non-alcoholic Beverages	34.6	3.5	15.9
i) Non- perishable Food Items	29.6	5.5	12.4
ii) Perishable Food Items	5.0	-7.1	34.7
Alcoholic Beverages& Tobacco	1.0	10.7	21.9
Restaurant & Hotels	6.9	5.5	7.0
Clothing &Footwear	8.6	6.4	9.5
Housing, Water, Electricity, Gas & other Fuel	23.6	8.2	7.1
Furnishing &Household Equipment Maintenance	4.1	7.2	10.6
Health	2.8	6.5	11.7
Transport	5.9	15.7	15.0
Communication	2.2	2.3	3.8
Recreation & culture	1.6	6.5	6.8
Education	3.8	9.4	6.0
Miscellaneous	4.9	7.9	11.9

Table 9: Wholesale Price Index (WPI)

Data Source: Pakistan Economic Survey 2019-20

3.5 Trade and Payments

Exports stood at $19.8 billion between July-April 2019, against $20.1 billion between July-March 2018-201, which shows a fall of 2.4%. [11] Owing to the market-based exchange rate and the government's plan to supply cheaper energy to the textile industry, a significant decline in REER has boosted the attractiveness of Pakistani goods in the international market. Total imports decreased to $36.1 billion in July-April 2020 compared with $40.3 billion last year, thus dropping by 16.9 Current FY-2020, remittances rose to 18.8 billion dollars from 17.8 billion dollars as compared to last financial year, with

a growth of 5.5% [26]. The current deficit account (CAD) decreased from $10.3 billion last year to $2.8 billion during July-March FY-2020 (1.1% of GDP) by 73.1% (3.7% of GDP) [20]. The substantial decrease in CAD mainly reflected the effect of government-led initiatives on macroeconomic stabilization.

At the end of March 2020, Pakistan's gross liquid foreign exchange reserves had risen to US$ 17.1 billion, an increase of US$ 2.6 billion relative to the end of June 2019 [25]. Throughout July-February, the Pakistani Rupee rose 3.6% compared to US Dollars in the current FY-2020, leading to an increase in the reserves of foreign exchange [25]. The COVID-19 pandemic has triggered shocks in demand and supply across the globe and has raised big obstacles for exports and continued to grow in the coming months. In terms of decreased import bills and as a result fall in CAD, Pakistan as a net importer of Oil will gain better benefits from the reduction in oil prices across the world. The total external liquidity of the budget has increased, considering the detrimental effect of the pandemic on the economy, thanks to the fall in oil and other foreign product prices.

World Economic Outlook April 2020 predicts that the global economy will sink dramatically by 3% because of COVID-19; far more than the financial crisis of 2008-09 [27]. The world economy is predicted to rise by 5.8% in 2021 because of the decaying pandemic in the second half of 2020 due to structured economic activity. With the current global situation, though, the economic outlook is at risk of weakening.

Tourism, commerce, and remittances are the core components of the international economy. Global trade in terms of goods is estimated to decrease by 13% according to World Trade Organisation (WTO) in 2020 to 32% because of COVID-19 [20]. Trade volumes are projected to fall by double digits in almost all territories throughout 2020, depending on the duration of the outbreak and the efficiency of the government response. It is also expected that the trade-in service sector will be adversely affected because of traffic restrictions implemented due to pandemics. In 2019, trade in goods declined by 0.1% due to continuing trade tensions and declining economic development.

The commercial ties between Pakistan and other trading partners are very significant. Pakistan with China has signed a trade agreement which is China-Pakistan Free Trade Agreement (CPFTA) is a significant achievement for Pakistan’s trade with China. Due to that agreement Pakistan get favourable access to 313 items which have main goods Pakistan used to export from China. Pakistan has also had an Electric Data Exchange (EDE) agreement to avoid the under-invoicing and misdeclarations of items. Apart from that, Pakistan is Thailand's second-largest trade partner in South Asia and there is a tremendous potential to increase bilateral trade. Pakistan has made a trade agreement with Thailand which is known as a Pak-Thailand Free Trade Agreement (PATHFTA). Both

countries under the mutual agreement gained the access to 200 priority items under Pak-Thailand Free Trade Agreement (PATHFTA). Pakistan-Sri Lanka Free Trade Agreement (PSFTA) came into existence on 12th June 2005. The PSFTA provided for duty-free exports to Sri Lanka per year of a 6000 MT quota of Basmati rice. This quota can only be used for two separate types of rice, namely PK 385 and Super Kernel. In December 2019, however, the list of rice that has duty free access was also included by the three latest rice variants which are Mega Basmati Rice, 1121 Kainat Rice, PK 198/D 98 Basmati Rice. In the duration from July-March 2020, overall bilateral trade from the Middle East to Pakistan amounted to US$3,272,04 million. In 2018-19, Pakistan's gross bilateral trade with Africa amounted to around $4.2 billion [20]. During July-February FY-2020, the Ministry of Commerce's Look Africa Policy Initiative rose to US$1030 million compared to US$ 937 million last year [26]. But the net imports dropped to US$1900 million in July-February FY2020 relative to US$1982 million in the same timeframe last year [23]. The data relating to Pakistan's imports and export its partner countries and major markets for Pakistani exports are provided as under in the following tables.

Country	2016-17		2017-18		2017-18		July-March			
							2018-19		2019-20 P*	
	Rs**	% Share	Rs	% Share	Rs	% Share	Rs	% Share	Rs	% Share
USA	361.1	16.9	400.4	15.7	532.8	17.0	384.6	17.0	471	17.3
CHINA	153.8	7.2	185.7	7.3	259.6	8.3	180	8.0	219	8.0
AFGHANISTAN	133.1	6.2	165.2	6.5	176.4	5.6	128.5	5.7	115.6	4.2
UNITED KINGDOM	163.1	7.6	186.7	7.3	226.8	7.3	166.9	7.4	194.7	7.1
GERMANY	125.1	5.9	146.7	5.7	173.4	5.5	125.6	5.5	162.1	5.9
U.A.E	83	3.9	104	4.1	125.8	4.0	77.3	3.4	141.6	5.2
BANGLADESH	65.4	3.1	81	3.2	101.8	3.3	77.8	3.4	91.8	3.4
ITALY	68.6	3.2	84.5	3.3	107.4	3.4	74.3	3.3	92.4	3.4
SPAIN	85.5	4.0	104.5	4.1	126.5	4.0	93.2	4.1	109.2	4.0
FRANCE	38.8	1.8	45.5	1.8	53.9	1.7	39.1	1.7	44.8	1.6
All Other	860.7	40.3	1050.8	41.1	1243.8	39.8	916.4	40.4	1083	39.7
Total	2138.2	100.0	2555	100.0	3128.2	100.0	2263.7	100.0	2725.2	100.0
P*is a Provisional, Rs is in Billion & Percentage Share**										

Table 10: Major Exports Markets of Pakistan

Data Source: Pakistan Bureau of Statistics

Particulars	Units	July-March Values in $Million			July-March Quantity		
		2018-19	2019-20 (P)	% Change	2018-19	2019-20 (P)	% Change in Quantity
Total		17071.1	17443.3	2.2			
A. Food Group		3348.1	3396	1.4			
Rice	M.T	1487.9	1,594.0	7.1	2987081	3146014	5.3
Sugar	M.T	115.1	70.7	-38.6	377679	181447	-51.9
Fish & Fish Preparation	M.T	293.9	317.3	8.0	129704	133226	2.7
Fruits	M.T	369.2	379.5	2.8	694855	725199	4.4

	Vegetables	M.T	167.8	257.9	53.7	738657	731974	-0.9
	Wheat	M.T	122	11.4	-90.7	558061	48083	-91.4
	Spices	M.T	68.7	66.8	-2.8	17303	16487	-4.7
	Oil Seeds, Nuts & Kernels	M.T	69.5	27.8	-60.0	48123	20052	-58.3
	Meat & Meat Preparation	M.T	156.4	233.0	49.0	42892	62727	46.2
	Other Food Items		497.6	437.7	-12.0			
B.	**Textile Manufactures**		9989.5	10,412.9	4.2			
	Raw Cotton	M.T	15.7	17.0	8.3	9699	12776	31.7
	Cotton Yarn	M.T	835.7	819.8	-1.9	320128	336437	5.1
	Cotton Cloth	TH.SQM	1595.9	1,548.2	-3.0	2122959	1923102	-9.4
	Knitwear	TH.DOZ	2154.6	2,299.9	6.7	89530	96837	8.2
	Bed wear	M.T	1719.4	1,761.6	2.5	312324	337065	7.9
	Towels	M.T	588.1	591.5	0.6	141991	144854	2.0
	Readymade Garments	TH.DOZ	1955.8	2,170.5	11.0	38742	42785	10.4
	Made-up articles		519	491.9	-5.2			
	Other Textile Manufactures		605.3	712.6	17.7			
C.	**Petroleum Group**		361.7	238.9	-33.9			
	Petroleum Products	M.T	107.1	39.7	-62.9	147326	80147	-45.6
	Petroleum Top Neptha	M.T	47.8	46.5	-2.7	84880	100111	17.9
D.	**Other Manufactures**		2,492.1	2,425.9	-2.7			
	Carpets, Rugs & Mats	TH.SQM	50.7	48.7	-3.9	1183	1260	6.5
	Sports Goods	TH.DOZ	222.9	222.2	-0.3			
	Leather Tanned	TH.DOZ	187.9	151.3	-19.5	16087	13644	-15.2
	Leather Manufactures		358.8	401.0	11.8			
	Surgical Goods. & Med. Inst.		279.8	303.0	8.3			
	Chemical & Pharma. Pro.		841.9	734.5	-12.8			
	Engineering Goods		126.4	140.4	11.1			
	Jewellery		3.8	3.2	-16.5			
	Cement	M.T	221.3	210.1	-5.1	5206393	5586355	7.3
	Guar & Guar Products	M.T	26.6	27.3	2.4	16813	19923	18.5
	All Other Manufactures		198.6	211.6	6.5			
E.	**All Other items**		1,086.5	1,122.2	3.3			

Table 11: Structure of Exports of Pakistan

Data Source: Pakistan Economic Survey 2019-20

Particulars	Units	July-March Value in $ Million	%	July-March Quantity	% Change in

			2018-19	2019-20 (P)	Change in Value	2018-19	2019-20 (P)	Quantity
	Total		40,679.7	34,790.6	-14.5			
A.	**Food Groups**		4,261.4	3,963.3	-7.0			
	Milk & Milk food	M.T	185.8	125.2	-32.6	76819	49802	-35.2
	Wheat Unmilled	M.T	-	-	0.0	-	-	0.0
	Dry Fruits	M.T	33.8	24.1	-28.7	18977	16747	-11.8
	Tea	M.T	445.8	376.2	-15.6	170311	155528	-8.7
	Spices	M.T	111.7	119.4	6.9	96253	103013	7.0
	Edible Oil (Soyabean & Palm)	M.T	1,454.6	1,425.5	-2.0	2413601	2342943	-2.9
	Sugar	M.T	3.0	2.3	-21.0	5910	4510	-23.7
	Pulses	M.T	393.4	428.8	9.0	737551	848472	15.0
	Other Food Items		1,633.4	1,461.8	-10.5			
B.	**Machinery Group**		6,716.0	6,633.2	-1.2			
	Power generating Machines		955.6	925.8	-3.1			
	Office Machines		341.0	287.4	-15.7			
	Textile Machinery		379.5	350.6	-7.6			
	Const. & Mining Machines		177.8	167.9	-5.6			
	Aircrafts, Ships and Boats		222.0	240.7	8.4			
	Agriculture Machinery		101.1	73.2	-27.6			
	Other Machinery Items		2,408.0	1,739.9	-27.7			
C.	**Petroleum Group**		10,614.0	8,900.6	-16.1			
	Petroleum Products	M.T	4,623.0	3,964.7	-14.2	7591057	7896482	4.0
	Petroleum Crude	M.T	3,379.0	2,452.6	-27.4	6563416	5521957	-15.9
D.	**Consumer Durables**		2,844.1	2,406.6	-15.4			
	Road Motor Vehicles		1,810.9	943.4	-47.9			
	Electric Mach. & Appliances		1,321.2	1,750.6	32.5			
E.	**Raw Materials**		5,787.7	5,051.2	-12.7			
	Raw Cotton	M.T	412.4	556.1	34.8	224575	336658	49.9
	Synthetic Fibre	M.T	427.2	339.1	-20.6	214517	227528	6.1
	Silk Yarn (Synth & Arti)	M.T	485.3	429.9	-11.4	220055	210417	-4.4
	Fertilizer Manufactured	M.T	716.0	482.3	-32.6	1709759	1429951	-16.4
	Insecticides	M.T	135.2	108.6	-19.7	21070	18999	-9.8
	Plastic Material	M.T	1,627.9	1,490.2	-8.5	1122987	1199206	6.8
	Iron & steel Scrap	M.T	1,108.9	1,188.2	7.2	3638564	3044891	-16.3
	Iron & steel	M.T	1,657.1	1,159.3	-30.0	2426840	1796710	-26.0

F.	**Telecom**	1,031.1	1,337.8	29.7
G.	**All Other Items**	14,167.8	11,828.	-16.5

Table 12: Structure of Imports of Pakistan

Data Source: Pakistan Economic Survey 2019-20

3.6 Public Debt

Pakistan's debt burden relief policy on a realistic scale involves promises for basic surpluses, low and steady inflation maintenance, encouraging policies that encourage stronger long-term economic growth and pursuing an economic fundamentals-based exchange rate system. At the end of March 2020, the total debt of Rs 35,207 billion was reported particularly in comparison with Rs 32,708 billion at the end of June 2019, a rise of Rs 2.499 billion over the first nine months, while a deficit-financing debt of Rs 2.080 billion was lent by the Federal Government [25]. This discrepancy is mainly attributed to the deterioration of Pak Rupee, the rise in the Federal Government's cash balances and the gap between the nominal value (which is used to record debt) and the realized value (which is recorded as a discretionary receipt) of GDP given over the time.

Over the current fiscal year, the public debt portfolio has seen numerous encouraging changes. The bulk of the net domestic debt was generated by medium-to-long-term government securities (Pakistan Investment Bonds (PIBs)). Long-term Government bonds also significantly dropped their rate of borrowing. During the current fiscal year, no new SBP loan has been made. The government launch of the 5-Year Sukuk Floating Rate has officially started to diversify the investor base in government securities and build on the liquidity of the Islamic Financial System. In the first nine months of the present financial year, all net foreign loans collected were concessional from multilateral and bilateral sources.

It is interesting to know that 70% of SBP reprofiling has been achieved with floated PIBs. Resultantly, the government continues to remain very close to the debt-refix / interest rate cap. Interest rate risk exposure decreased marginally when one year's percentage of debt re-fixing decreased to about 55% in June 2019 likely to 56% in the previous FY-2018 [20]. Moving ahead, the government inclines to lend furthermore money by fixed-rate instruments to lower the interest rate burden of its public debt portfolio

At the end of March 2020, national domestic debt amounted to Rs 22,478 billion. Despite the difficult macroeconomic situation, domestic borrowing continued very effectively for the current financial year. In the first nine months of the current fiscal year, foreign debt stocks surpassed US$76.5 billion

(Rs 12.729 billion), seeing an expansion of US$3.0 billion [23]. Thanks to the re-profiling of short-term debt into long-term debt and a sharp reduction in financing rates in longer terms, interest rates are projected to continue to stay slightly lower than the budgeted level in 2019-2020.

In the medium term, the government's goal is to mitigate its Gross Funding Needs (GFN) through numerous steps such as enhancing cash flow control through a single treasury account, expanding domestic market maturities because of trade-off costs and risks, establishing an Islamic-based loan program, and allowing the use of the maximum available concessional external financing from bilateral and multilateral development partners to benefit from concessional terms and conditions. In addition to that, the government also tries to carry and preserve its Debt-to-GDP and Debt Service-to-Revenue ratios to manageable standards by combining higher revenue mobilization, current spending rationalization and debt efficient/productive usage.

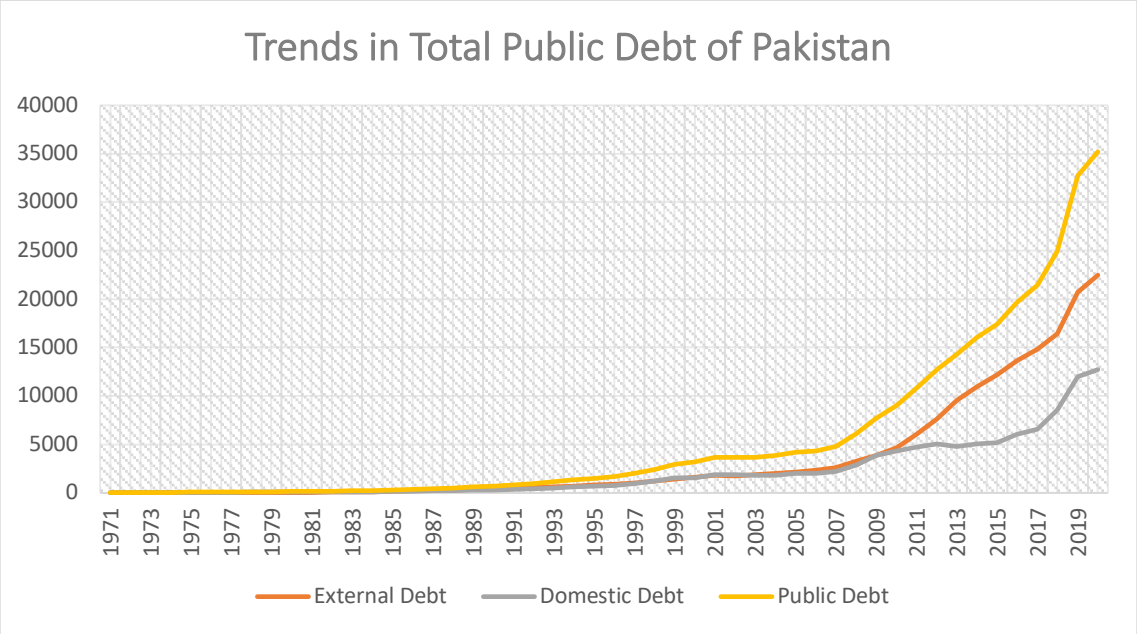
However, the Total Public Debt according to the Fiscal Responsibility and Debt Reduction Act 2005 is interpreted as a debt borrowed by Federal as well as Provincial Governments serviced out of consolidated funds and debts owed to the International Monetary Fund. In comparison, the country's total debt and liabilities comprise total public debt (government debt) as well as other sectors' debt, which can be seen in the table below.

(Rs in billion)	2015	2016	2017	2018	2019	Mar-20
I. Government Domestic Debt	12,192.5	13,625.9	14,849.2	16,416.3	20,731.8	22,477.7
II. Government External Debt	4,770.0	5,417.6	5,918.7	7,795.8	11,055.1	11,658.1
III. Debt from IMF	417.6	633.1	640.8	740.8	921.0	1,071.3
IV. External Liabilities[1]	377.6	377.1	373.8	622.3	1,710.1	1,642.5
V. Private Sector External Debt	539.2	709.1	1,183.2	1,654.5	2,481.3	2,634.4
VI. PSEs External Debt	252.7	294.0	285.2	324.6	630.6	582.0
VII. PSEs Domestic Debt	458.7	568.1	822.8	1,068.2	1,394.2	1,397.7
VIII. Commodity Operations[2]	564.5	636.6	686.5	819.7	756.4	649.3
IX. Intercompany External Debt from Direct Investor abroad	276.6	315.6	353.9	437.2	542.7	707.5
A. Total Debt and Liabilities (sum I to IX)	19,849.4	22,577.1	25,114.2	29,879.4	40,223.1	42,820.3
C. Total Public Debt (sum I to III)	17,380.2	19,676.6	21,408.7	24,952.9	32,707.9	35,207.0
D. Total Debt of the Government[3]	15,986.0	17,823.2	19,635.4	23,024.0	29,520.7	31,452.4
Memorandum Items						
GDP (current market price)	27,443.0	29,075.6	31,922.3	34,616.3	37,972.3	41,726.7
Government Deposits with the banking system[4]	1,394.1	1,853.5	1,773.3	1,928.9	3,187.2	3,754.6
US Dollar, last day average exchange rates	101.8	104.8	104.9	121.5	163.1	

1. **External Liabilities include Central bank deposits, SWAPS, Allocation of Special Drawing Rights (SDR) and non-resident LCY deposits with central bank.**
2. **Includes borrowings from banks by provincial governments and PSEs for commodity operations**
3. **As per Fiscal Responsibility and Debt Limitation Act, 2005 amended in June 2017, "Total Debt of the Government" means the debt of the government (including the Federal Government and the Provincial Governments) serviced out of the consolidated fund and debts owed to the International Monetary Fund (IMF) less accumulated deposits of the Federal and Provincial Governments with the banking system.**
4. **Accumulated deposits of the Federal and Provincial Governments with the banking system.**

Table 13: Pakistan's Debt and Liabilities

Data Source: State Bank of Pakistan



Graph 10: Trends in Total Public Debt of Pakistan since 1971

Data Source: data.worldbank.org

Year	Domestic Debt	External Debt	Public Debt	Year	Domestic Debt	External Debt	Public Debt	Year	Domestic Debt	External Debt	Public Debt
(Rs in Billion)											
1971	14	16	30	1988	290	233	523	2005	2,178	2,034	4,211
1972	17	38	55	1989	333	300	634	2006	2,322	2,038	4,359
1973	20	40	60	1990	381	330	711	2007	2,601	2,201	4,802
1974	19	44	62	1991	448	377	825	2008	3,274	2,853	6,127
1975	23	48	70	1992	532	437	969	2009	3,860	3,871	7,731
1976	28	57	85	1993	617	519	1,135	2010	4,653	4,357	9,010
1977	34	63	97	1994	716	624	1,340	2011	6,014	4,756	10,771
1978	41	71	112	1995	809	688	1,497	2012	7,638	5,059	12,697
1979	52	77	130	1996	920	784	1,704	2013	9,520	4,771	14,292
1980	60	86	146	1997	1,056	939	1,995	2014	10,907	5,085	15,991
1981	58	87	145	1998	1,199	1,193	2,392	2015	12,193	5,188	17,380
1982	81	107	189	1999	1,389	1,557	2,946	2016	13,626	6,051	19,677
1983	104	123	227	2000	1,645	1,527	3,172	2017	14,849	6,559	21,409
1984	125	132	257	2001	1,799	1,885	3,684	2018	16,416	8,537	24,953
1985	153	156	309	2002	1,775	1,862	3,636	2019	20,732	11,976	32,708
1986	203	187	390	2003	1,895	1,800	3,694	Mar-20	22,478	12,729	35,207
1987	248	209	458	2004	2,028	1,839	3,866				

Table 14: Trends in Total Public Debt of Pakistan

Data Source: data.worldbank.org

3.7 Education

The education sector of Pakistan is facing many issues. To resolve these issues, the Pakistani government has formulated the National Education Policy Framework, which includes: the increasing children enrolment in schools and to increase the number of school completion children; homogeneity in the standard of education among government and private schools; improvement in education quality; and better access to comprehensive training. The literacy rates of the population 10 years old and higher project as 60% in the year 2018-19 compared to 58% in 2015-2015, as per the research of Pakistan Social and Living Standards Measurement Survey (PSLM) for 2018-19. In the urban areas of Pakistan with the rate of 74%, literacy is significantly greater compared to rural areas with 51%. Furthermore, the research says that Punjab has the highest literacy rate with 64% in the country, that there comes the province Sindh with a literacy rate of 57% then province Khyber Pakhtunkhwa (Excluding Merged Areas) with the literacy rate of 55%, and Baluchistan is the province with least literacy rate which is about 40%.

In 2018-19, public education spending was projected at 2.3% of GDP, compared with 2.4% in FY-2018. Comparison to the previous financial year, education-related spending rose by 4.7% (to Rs 868.0 billion) in 2018-19. Under the Ministry of Federal Education & Skilled Training, the Federal PSDP issued a sum of Rs 4.8 billion to 11 existing and 21 new infrastructure improvements and development projects. In addition, to Ministry of Economy, Defence, the Interior and Kashmir & Gilgit Baltistan have

Province/Area	**2015-16**			**2018-19**		
	Male	Female	Total	Male	Female	Total
Pakistan	70	48	58	71	49	60
Rural	63	36	49	65	38	51
Urban	81	68	74	80	67	74
Punjab	72	54	62	73	57	64
Rural	66	44	55	67	47	57
Urban	82	73	77	82	73	77
Sindh	67	44	55	68	44	57
Rural	51	19	36	55	21	39
Urban	80	65	73	79	64	72
Khyber Pakhtunkhwa (Including Merged Areas)	-	-	-	75	36	55
Rural	-	-	-	74	33	52
Urban	-	-	-	82	51	66
Khyber Pakhtunkhwa (Excluding Merged Areas)	72	36	53	76	40	57
Rural	70	33	50	81	54	67

Table 15: Literacy Rate of Provinces of Pakistan

Data Source: Pakistan Bureau of Statistics

been given a sum of 1.1 billion Rs for eight existing and new education project projects. On the other hand, Higher Education Commission (HEC) Pakistan received Rs 29,047 billion for the execution of 138 construction projects (128 ongoings and 10 new projects) of public sector universities and higher education institutions. During the span of July-March, Funds has been approved by HEC to complete its ongoing projects by issuing an amount of Rs 22,738 billion (around 80% of the overall allocation).

The current government is seeking to create a single national curriculum throughout the nation. To achieve the aim of the uniform syllabus in the country, Phase-I has been established and implementation is expected to complete by March 2021 for Single Curriculum for Class 1 and 5. In the same way, Phase II will have been ready and adopted by March 2021 by Single national curriculum for classes 6 to 8 and Phase III would be ready by March 2022 for classes 9 to 12 which will be implemented through the country by March 2023.

Years		Current Expenditure	Development Expenditure	Total Expenditure	As % of GDP
2014-15	Federal	73,729	28,293	102,022	2.2
	Punjab	201,882	25,208	227,090	
	Sindh	109,275	7,847	117,122	
	Khyber Pakhtunkhwa	83,205	28,506	111,711	
	Balochistan	32,299	8,803	41,102	
	Pakistan	**500,390**	**98,657**	**599,047**	
2015-16	Federal	84,496	34,665	119,161	2.3
	Punjab	224,608	26,863	251,471	
	Sindh	123,855	11,153	135,008	
	Khyber Pakhtunkhwa	92,306	19,925	112,231	
	Balochistan	36,121	9,364	45,485	
	Pakistan	**561,386**	**101,970**	**663,356**	
2016-17	Federal	91,139	16,890	108,029	2.2
	Punjab	221,049	39,593	260,642	
	Sindh	134,650	12,082	146,732	
	Khyber Pakhtunkhwa	109,482	26,639	136,121	

	Balochistan	40,571	7,127	47,698	
	Pakistan	**596,891**	**102,331**	**699,222**	
2017-18	Federal	100,428	26,495	126,923	**2.4**
	Punjab	295,893	44,910	340,803	
	Sindh	152,298	13,705	166,003	
	Khyber Pakhtunkhwa	126,149	16,494	142,643	
	Balochistan	47,107	5,673	52,780	
	Pakistan	**721,875**	**107,277**	**829,152**	
2018-19(P)	Federal	103,787	21,780	125,567	**2.3**
	Punjab	339,402	32,413	371,815	
	Sindh	153,492	9,110	162,602	
	Khyber Pakhtunkhwa	132,516	20,195	152,711	
	Balochistan	49,298	6,029	55,327	
	Pakistan	**778,495**	**89,527**	**868,022**	

Table 16: Expenditure on Education

Data Source: Pakistan Bureau of Statistics

3.8 Capital Market and Corporate Sector

Capital markets leverage and effectively channel domestic assets into the most profitable investment. They play an important role in economic development, as they promote real-world growth through the availability of long-term funding for manufacturers of goods and services. Therefore, mature capital markets are vital to global development and stability. Cross-cutting convergence of global capital markets made access to global capital simpler for businesses. Connection to global capital markets increases portfolio diversification possibilities for clients. Connection to global capital markets for receiving countries encourages countries to borrow in the face of adverse shocks to smooth consumption. However, in the sense of the increasingly transparent account, it has been accepted that the possibility of sudden reversals of capital flows may be substantial.

Pakistan maintains its spot in the evolving Morgan Stanley Capital International (MSCI) Emerging Markets (EM). To be categorized into EMs, at least three firms must have a float market capitalization of $766 million and a market capitalization of $1.5 billion [28]. In the MSCI Emerging Market, there are three Pakistani organizations listed which are the Oil & Gas Development Company, Habib Bank,

and MCB Bank Ltd. One elimination of the three will lead to Pakistan being reduced to the Frontier Sector Index.

Pakistan and the IMF negotiated a $6 billion fund for a 39-month Extended Fund Facility (EFF) framework for Pakistan in the first quarter of FY-2020 to minimize economic uncertainties and to stimulate continuous improvement [23]. Austerity measures were taken by the government and a double-digit policy rate was introduced by the State Bank of Pakistan (SBP). Development and spending have been limited with the Stability Program. International investors and money started to flood into the Pakistani debt market with a high-interest rate. But the COVID-19 pandemic and decreasing petroleum prices shook up the markets. In reaction to instability, foreign investors realized to save their assets from further deterioration, they must sell their stocks and bonds, as well as in Pakistan from emerging markets. A variety of steps have been taken by the government, the SBP, and the Securities and Exchange Commission of Pakistan (SECP) to regain investor trust. These measures were aimed to gain better results in the fronts of equity, debt, commodity futures, non-banking, corporate, Islamic finance, and insurance sectors in FY2020 and these measured prove to be successful in getting better results in such areas. The period of index-based market stops was raised to 60 minutes from 45 minutes; securities brokers were licensed to enable and run Catastrophe Relief Terminals for commercial purposes in daily PSX operations. The Corporate Recovery, 2019 and Rules of Practice of the Corporate Restructuring Firms have already been advised to SECP.

In the first ten months of FY2020, Pakistan's KSE-100 benchmark reported a marginal rise of 0. 61%. On 1 July the index started with 33.901.58 points and hit its highest in the year on 13 January 2020 at 43218.67 points. The outbreak of COVID-19 took money out from Pakistan's financial market and on 25 March the index fell to 27228.8 points and market capitalization closed at Rs 5380.17 billion [28]. But, as the KSE-100 index gained 6,877,84 points (Also 25,25%) after March 25, the Government stimulus package gave relief to investors, and on 30 April the Index closed at 34,111,64 points. Similarly, Rs 991.54 billion (18.4%) has raised market capitalization since 25 March and ended at Rs 6376.71 billion on 30th April [20].

Sectors	Number of listed companies	Market cap on 01/07/2019 (Rs Million)	Market cap on 03/31/2020 (Rs Million)	Percent Change
Automobile assembler	13	247,717.08	186,203.69	-24.8%
Automobile parts & accessories	09	47,103.45	38,707.71	-17.8%
Cable & electrical goods	07	25,203.75	20,757.59	-17.6%
Cement	22	306,192.39	317,594.18	3.7%
Chemical	27	273,461.23	264,209.75	-3.4%
Close - end mutual fund	06	5,158.51	3,253.83	-36.9%
Commercial banks	20	1,284,983.50	1,013,621.54	-21.1%
Engineering	19	56,935.49	57,344.73	0.7%
Fertilizer	06	440,313.20	417,033.98	-5.3%

Food & personal care products	24	537,140.29	550,206.71	2.4%
Glass & ceramics	11	35,787.19	31,710,.45	-11.4%
Insurance	29	136,743.45	127,078.49	-7.1%
Inv. banks / inv. cos. / securities cos.	30	90,597.53	85,656.43	-5.5%
Jute	02	123.30	123.30	0.0%
Leasing companies	30	4,927.25	4,283.22	-13.1%
Leather & tanneries	05	18,281.82	23,614.76	29.2%
Miscellaneous	09	62,375.12	59,833.89	-4.1%
Modarabas	30	12,432.58	11,435.56	-8.0%
Oil & gas exploration companies	04	1,130,640.63	719,825.77	-36.3%
Oil & gas marketing companies	09	194,363.60	141,425.31	-27.2%
Paper & board	10	45,307.66	41,388.57	-8.6%
Pharmaceuticals	12	174,445.35	202,829.98	16.3%
Power generation & distribution	17	304,047.13	230,391.06	-24.2%
Refinery	04	56,227.64	45,001.38	-20.0%
Sugar & allied industries	29	57,022.22	64,451.37	13.0%
Synthetic & rayon	11	35,754.10	42,842.45	19.8%
Technology & communication	12	73,508.90	62,772.74	-14.6%
Textile composite	58	242,099.65	191,154.87	-21.0%
Textile spinning	69	41,875.0	40,515.72	-3.2%
Textile weaving	11	2,466.84	2,648.63	7.4%
Tobacco	03	860,224.66	534,128.93	-37.9%
Transport	05	52,916.36	58,203.81	10.0%
Vanaspati & allied industries	06	6,854.94	6,445.37	-6.0%
Woollen	02	1,453.76	1,518.40	4.4%
Real estate investment trust	01	22,615.02	22,726.21	0.5%
Exchange traded funds	02	N/A	0.39	N/A
Total		6,887,300.78	5,620,940.91	-18.4%

Table 17: Market Capitalization of Each Sector

Data Source: Pakistan Economic Survey 2019-20

Months	**2018 – 2019**			**Months**	**2019 – 2020**		
	KSE 100 index	**Market Capitalization (Rs Billion)**	**Turnover in shares (Billions)**		**KSE 100 index**	**Market Capitalization (Rs Billion)**	**Turnover in shares (Billions)**
Jul-18	42,712.43	8,749.52	3.75	**Jul-19**	31,938.48	6,384.30	1.76
Aug-18	41,742.24	8,677.98	3.6	**Aug-19**	29,672.12	6,082.04	2.03
Sep-18	40,998.59	8,402.82	2.49	**Sep-19**	32,078.85	6,406.55	2.18
Oct-18	41,649.36	8,321.42	5.03	**Oct-19**	34,203.68	6,690.04	4.37
Nov-18	40,496.03	8,067.33	4.16	**Nov-19**	39,287.65	7,511.97	6.40
Dec-18	37,066.67	7,692.79	2.71	**Dec-19**	40,735.08	7,811.81	6.45
Jan-19	40,799.52	8,124.08	3.24	**Jan-20**	41,630.93	7,851.16	5.68
Feb-19	39,054.60	7,817.67	2.92	**Feb-20**	37,983.62	7,094.67	2.91
Mar-19	38,649.34	7,868.61	2.53	**Mar-20**	29,231.63	5,620.94	4.71
Apr-19	36,784.44	7,505.31	3.29	**Apr-20**	34,111.64	6,376.72	4.60
May-19	35,974.79	7,240.44	2.77				
Jun-19	33,901.58	6,887.30	2.57				

Table 18: Month-wise performance of KSE-100 Index

Data Source: Pakistan Stock Exchange (PSX)

3.9 Climate

One of the main threats to the survival of life on earth is the quickly evolving climatic changes. A big cause of environmental deterioration is the phenomenon of global temperature rise. The increased emissions of greenhouse gas (GHG) into our thermosphere due to the burning of fossil fuels contributes not only to an increase in air pollution but also to the overall Earth temperature. The transition in climes impacts both human life and the economy by influencing environmental structures on Earth which causes other natural occurrences such as floods, famines, droughts, and cyclones. Climate change in Pakistan is likely to have a large range of consequences, such as lower farming yield, heightened water insecurity, dramatically increased seawater incursions and coastal erosion and enhanced severe weather frequency.

In the past 20 years, because of its geographical position, Pakistan has indeed been listed amongst the leading ten countries that have been most seriously impacted by climate change worldwide. According to the Annual Estimate of the Global Climate Risk Index for 2020, Pakistan deprived 0.53% of GDP, experienced a deficit of 3,792.52 million dollars, and observed 152 severe natural disasters from 1999 to 2018 [20]. ADB assessments have shown that climate adjustment requires about $7 billion to $14 billion per year, to avoid global warming which is important for leading better socio-economic life on the globe [29]. The government of Pakistan is aware of the drastic environmental situation; therefore, it adopts policies and works for the implementation of these policies to reduce the detrimental effects of climate change in the world.

The Government has initiated the Eco-system Restoration Initiative (ESRI) with ecologically oriented measures through mitigation of environmental harming factors to promote the change towards ecologically sustainable Pakistan. These include afforestation, preservation of biodiversity, strengthening policies in line with Pakistan's Nationally Determined Contribution (NDC) targets and ensuring Land Degradation Neutrality (LDN). The plan seeks to create an autonomous, open, and systematic financial system for the project and plans. This mechanism is known in Pakistan as the Eco-Restoration Fund (ESRF). The following big action was taken by the Ministry of Climate Change (MOCC).

I. At COP-25, Pakistan's delegation earned 06 places for different committees under the United Nations Framework Convention on Climate Change (UNFCCC) to demonstrate confidence in Pakistan's contribution to climate negotiations.
II. Pakistan is sponsored by the NDC Alliance informing its climate-resistant growth path.

III. Climate Change Ministry is now updating the NDCs.in order to develop components for the NDC revision under the UNFCCC reporting, there will be a potential for cooperation on the evaluation, reporting and verification (MRV) and the GHG pollution inventory.

IV. Establishment of the National Committee for Carbon Market Establishment (NCEC)

V. In 20 cities, a "Clean-Green Cities Index" which prompted an enhancement in the waste disposal and sanitation, was launched. Pakistan agreed to avoid its plastic dependency by preventing plastic in one use

The Sustainable Development Goals (SDGs) on the protection of water and sanitation facilities are being established in partnership with key stakeholders and local provincial departments, launching of Green Pakistan Movement (CGPM). The Pakistani prime minister, who wants to promote safe and green conditions for all the people of Pakistan, initiated the CGPM as a national campaign.

Description	**Urban**		**Rural**		**Total**
	Water	Sanitation	Water	Sanitation	Total
New Services: Basic Access	13,968	12,797	8,595	28,543	63,883
New Services: Safely Managed	62,630	48,904	113,736	123,099	348,369
Sustaining existing services: Basic Access	16,635	11,100	11,110	20,735	59,580
Sustaining existing services: Safely Managed	36,229	11,100	33,461	20,735	101,525
Overall Financing Needs	98,849	60,004	147,197	143,834	449,894

Table 19: Annual Financial Needs for Safely Managed Water & Sanitation Services

Data Source: Ministry of Climate Change, Pakistan

Chapter Four

Energy Chaos cripple Economy of Pakistan

4 Chapter IV: Energy chaos in Pakistan cripple's economy

4.1 Overview of Energy sector

The demand for oil in Pakistan amounts to 19,68 million tons per year compared with the production from local refineries of 11,59 million tons per annum, while the rest of the 8,09 million tons are imported per annum. Pakistan's refineries are old except PARCO and manufacture over 40% of the lowest-priced commodity Furnace Oil. Total LPG availability was 739,785 metric tons from July to March 2019–20. At present, there are currently 11 LPG suppliers and more than 7,000 licensed LPG dealers and 200 LPG marketing firms employed in the nation. An investment of approximately Rs 3.72 billion in LPG infrastructure was made during July-March 2019-20. Due to supply restrictions and higher LPG costs compared to competing fuels such as natural gas, biomass, etc., LPG accounts for just 1.2 % of the overall primary energy supply in the country. Approximately 1,061,447 MT/annum are presently accessible in the LPG sector. Roughly 76% of the LPG consumed is produced locally in Pakistan, while the remaining is imported.

In addition, around 4 billion cubic feet per day (BCFD) of indigenous natural gas is generated by Pakistan. However, Pakistan has a vast gas network comprising more than 12,971 km transmission along with 139,827 KM Distribution and 37,058 gas pipelines for more than 9,6 million customers across Pakistan. During the period from 1 July 2019 to 31 March 2020, the Pakistan Atomic Energy Commission (PAEC) contributed round about 7.143 million units of electricity to the national grid. However, during July-December 2019, the import volume of cargo settled around 21,878 million tons, compared to 20,125 million tonnes handled compared to last year that shows a rise of 8.7%. Coal, LNG, POL, plastics, palm oil and grain became the main non-containerized imports. Coal imports accounted for over 34% of total imported merchandise.

The government aims to leverage the ample power generation capacity of wind, solar and other Alternative Renewable Energy options while benefiting from the decreased prices of RE technologies by optimal growth. In FY-2020, the share of hydro in overall power production rose relative to its share in FY2019. Thermal energy probably contributes the biggest share in the electricity production of the country. whereas other cheaper sources are gas and RLNG. The considerable rise in RLNG energy mix consumption has led to the productivity enhancements of numerous power stations, such as Bhikki, Haveli Bahadur Shah, Balloki, Halmore, Orient, Rousch, KAPCO, Sapphire and Saif. In addition, RLNG is

also supplied to the fertilizer factories, industrial and transport industries. The consumption of energy of different consumers usage levels for March 2020 and of the previous year can be seen as under:

	2019 (Jul-Apr)	2020 (Jul-Apr)	% Share 2019 (Jul-Apr)	% Share 2020 (Jul-Apr)
Hydroelectric	24931	27270	25.8	30.9
Thermal	61003	51629	63.0	58.4
Nuclear	2903	7049	3.0	8.2
Renewable	7955	2057	8.2	2.4
Total	96792	96382	100	100

Table 20: Share in Electricity Generation (GWH)

Data Source: Water and Power Development Authority Pakistan

Description/ Sectors	UNITS SOLD (MWH) Mar-19	UNITS SOLD (MWH) Mar-20	% Share Mar-19	% Share Mar-20
Household	2,180,190	2,296,190	38.07	44.90
Commercial	407,580	394,915	7.12	7.72
Industry	1,966,390	1,505,957	34.34	29.45
Agriculture	606,180	411,257	10.58	8.04
Others	566,700	505,245	9.90	9.88
Grand Total	5,727,040	5,113,567	100.00	100.00

Table 21: Share in Electricity Consumption

Data Source: Pakistan Bureau of Statistics

4.2 Divisional and Distribution structure of Power sector

The power sector's regulation to maintain efficiency, pricing, and proper distribution began in 1998 with the establishment of the National Electric Power Regulatory Authority (NEPRA). In 2002, NEPRA granted nine licenses to different Distribution Companies (DISCOs) ten of which were undertakings in the Water & Power Development Authority (WAPDA) scheme. A transmission business license for the WAPDA system was also given to the National Transmission and Dispatch Company (NTDC). The 10 DISCOs and NTDC act as government monopolies in the WAPDA network of production and transmission. Pakistan's electro power industry is troubled by financial and organizational problems impacting economic productivity and industry development.

However, following the tariff standards and procedures, the Discos used to determine the electricity rate for each entity following the consumption mix, distribution losses as well as keeping in view the operating costs of the DISCOs. The generation and transmission monopolies of government-owned distributor companies DISCO and NTDC, while government-owned generating companies (Genco) compete with private power producers in providing power to the grid. The structure of functionality and process is showed in the given figure:

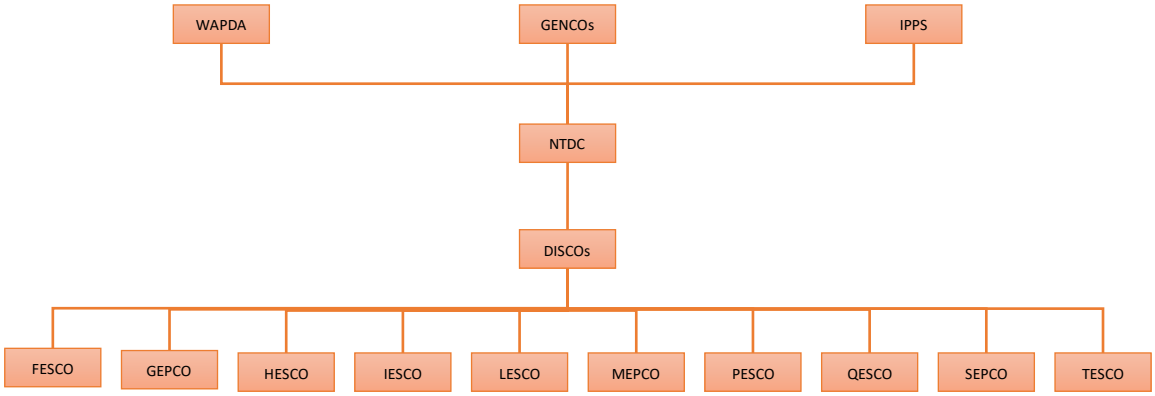


Figure 7: Flowchart of Distribution and Transmission Companies

4.2.1 Hyderabad Electric Supply Company (HESCO)

HESCO has split, administratively speaking, 12 districts of Sindh province into four operational zones, 15 operating and 67 operating sub-divisions, along with 6 structural elements and 5 M&T sections, by with an aim of uninterrupted supply of power to most intimate customer services to around 1,138,328 customers. The corporation looks for effective and efficient market management day and night.

Loading Position of 11 KV Feeder						
HESCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% Of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	37,305	37,896	1,080	1,211	2.90	3.20
Loading Position of Power Transformers						
HESCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% Of Total Over-Loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	121	122	34	26	28.10	21.31
Loading Position of Distribution Transformers						
HESCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% Of Total Over-Loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	37,305	37,896	1,080	1,211	2.90	3.20
Investment Allowed and Made by HESCO investment in Rs Million						

HESCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	3,895	4,993	3,067	4,729	550
	Actual	3,607	3,413	4,048	4,729	4,804

Table 22: Information regarding HESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.2 Lahore Electric Supply Company (LESCO)

Lahore Electric Supply Company (LESCO) Limited is an electricity distribution company serving more than 5.1 million customers in five districts of Punjab by transmission and distribution and possess a comprehensive network. The districts in which LESCO provide services of power transmission are Lahore, Kasur, Sheikhpura, Okara and Nankana districts. The organization has many years of expertise in transmission and delivery system service and repair. LESCO operates in an area which has a rising demand for electricity because of substantial industrial growth in these districts. On 18 February 1998, LESCO was established as a public limited corporation by the Companies Ordinance of 1984. As a result of the reform of the power sector in Pakistan the conversion of Area Electric Boards into Public Limited Companies has led to all Area Electric Boards becoming Public Limited Companies.

Loading Position of 11 KV Feeder						
LESCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	110,092	116,030	26,532	25,743	24.1	22.19
Loading Position of Power Transformers						
LESCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	391	404	78	66	19.95	16.34
Loading Position of Distribution Transformers						
LESCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	110,092	116,030	26,532	25,743	24.10	22.19
Investment Allowed and Made by LESCO investment in Rs Million						
LESCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018

	Allowed	8,247	8,247	10,826	19,781	21,459
	Actual	4,820	7,338	8,050	9,758	12,081

Table 23: Information regarding LESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.3 Gujranwala Electric Supply Company (GEPCO)

The former electricity board, founded at the beginning of the eighties, was designing Gujranwala Electric Power Company Limited (GEPCO). The current districts of Gujranwala, Hafizabad, Sialkot, Narowal, Gujrat and Mandi Bahauddin were covered by GEPCO. On 25 April 1998, GEPCO was incorporated and got a certificate for start-up on 5 June 1998. In the early sixties, Government of Pakistan (GOP) agreed to create a separate and independent entity to deal with any available water supplies and electricity grid, including electricity generation, transmission, and distribution. This department was formed and called as WAPDA, which is Pakistan's second largest post-Pakistan Army department. In the 1980s WAPDA's power distribution network was sub-divided into eight District Electricity Boards. Gujranwala was one of the AEBs of the multiple Power Distribution Boards. GEPCO has approximately 3098120 connections with average monthly receipt of roughly 8937 million rupees for the year 2016-17.

Loading Position of 11 KV Feeder						
GEPCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	67,587	72,005	1,959	1,942	3	2.70
Loading Position of Power Transformers						
GEPCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	176	173	25	15	14.20	8.67
Loading Position of Distribution Transformers						
GEPCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	67,587	72,007	1,959	1,942	2.90	2.70

Investment Allowed and Made by GEPCO investment in Rs Million						
GEPCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	4,561	5,058	2,892	2,775	3,200
	Actual	5,005	2,147	2,892	2,775	4,243

Table 24: Information regarding LESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.4 Faisalabad Electric Supply Company (FESCO)

In compliance with the Legislation of Electric Power Production, Transmission and Distribution Act of 1997, FESCO distributes and provides electricity for some 4,40 million consumers through its market area and has a population of over 26 million. Faisalabad, Sargodha, Mianwali, Khushab, Jhang, Bhakker, T.T Singh and the district of Chiniot constitute FESCO's regional operation area. Its primary coverage area is Faisalabad, recognized as Manchester of Pakistan because of its enormous textile industries. As it has low delivery losses and a large bill collection rate, FESCO is one of Pakistan's strongest electricity distribution firms in terms of operating efficiency.

Loading Position of 11 KV Feeder						
FESCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	108,652	113,079	614	652	0.57	0.58
Loading Position of Power Transformers						
FESCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	235	236	42	25	17.87	10.59
Loading Position of Distribution Transformers						
FESCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	108,652	113,079	614	625	0.57	0.58
Investment Allowed and Made by FESCO investment in Rs Million						
FESCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018

	Allowed	6,700	7,573	8,970	6,540	4,935
	Actual	4,205	3,285	6,621	8,033	3,502

Table 25: Information regarding FESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.5 Sukkur Electric Supply Company (SEPCO)

The SEPCO (Sukkur Electric Power Company) distribution company was established by subdividing HESCO, so that the regions of service solely underneath HESCO's authority have indeed been segregated in between the two DISCOs. SEPCO is a newly formed entity that was officially founded on 26 July 2010 and has been operating since 16 August 2010. HESCO has lost its historical boundaries, which are now under SEPCO's control. There are three operating zones form core part of the distribution framework of the SEPCO which are Sukkur, Larkana and Dadu.

Loading Position of 11 KV Feeder						
SEPCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	38,196	38,616	2,588	2,676	6.78	6.93
Loading Position of Power Transformers						
SEPCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	130	132	24	16	18.46	12.12
Loading Position of Distribution Transformers						
SEPCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	38,196	38,616	2,588	2,676	6.78	6.93

Investment Allowed and Made by SEPCO investment in Rs Million						
SEPCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	38,196	38,616	2,588	2,676	6.78
	Actual	38,196	38,616	2,588	2,676	6.78

Table 26: Information regarding SEPCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.6 Quetta Electric Supply Company (QESCO)

As a Power Delivery Firm, QESCO works and will work as a commercial entity to move from the public to the private sector. In the whole of Baluchistan excluding Lasbela City, QESCO operates regarding to its Power Distribution Scheme. In contexts of customers, QESCO is one of smallest DESCO, but it is largest in the terms of area coverage. It covers 43% of Pakistan's territory. At the moment, the maximum requirement is 1177 MW assessment steps and predicted to be 1659 MW with 8% standardized annual growth by the year 2020. Due to the large number of farming sector consumers, the QESCO framework has been under strain because these customers contributing between 70% to 80% of power demand. In addition to the existence of Guddu Single 220 KV sources, the low voltage profile prevails due to long distances from generation sources. In order to provide a supplemental supply, 2x220 KV Dadu-Khuzdar & DG Khan-Loralai Power Grids are accepted at the cost of Rs 5,437 and 5,089 billion respectively. An additional rental Powerhouse is also accessible at Quetta, Sibi and Khuzdar. By commissioning these 2x220 KV power sources and rental houses, the problems of low voltage profiles, which remain a common feature in Baluchistan, and the provision of additional 600-700 MW of power for provinces will be removed.

Loading Position of 11 KV Feeder

	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
QESCO	2019	2020	2019	2020	2019	2020
	60,870	62,337	7,049	6,814	11.58	10.93

Loading Position of Power Transformers

	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
QESCO	2019	2020	2019	2020	2019	2020
	174	177	66	51	37.98	28.81

Loading Position of Distribution Transformers

	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
QESCO	2019	2020	2019	2020	2019	2020
	60,870	62,337	7,049	6,814	11.58	10.93

Investment Allowed and Made by QESCO investment in Rs Million

QESCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	3,600	3,956	4,300	3,080	8,000

	Actual	3,301	4,145	7,115	3,080	4,748

Table 27: Information regarding QESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.7 Islamabad Electric Supply Company (IESCO)

In 1998, IESCO was created to hold up the facilities, roles, and duties of the former Islamabad District Electricity Board, which was then a WAPDA division. The main role of IESCO is to supply, distribute and sell electricity in the region from Attock to Jheleum, and from the Indus River to Kashmir's Neelum River. It specifically targets 2.8 million customers but impacts the lives of more than 25 million people living in their residential buildings in the six districts. It is dedicated to offer expertise in sustainability growth and to implementing the values of sustainability and to finding alternative and sustainable courses of action aimed at mitigating their effect on the atmosphere.

Loading Position of 11 KV Feeder						
IESCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	49,109	50,210	786	1,663	1.6	3.31
Loading Position of Power Transformers						
IESCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	257	263	8	9	3.11	3.42
Loading Position of Distribution Transformers						
IESCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	49,109	50,210	786	1,663	1.60	3.31

Investment Allowed and Made by IESCO investment in Rs Million						
IESCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	7,700	7,823	11,918	10,090	6,716
	Actual	4,438	4,827	5,195	5,313	6,716

Table 28: Information regarding IESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.8 Peshawar Electric Power Company (PESCO)

Peshawar Electric Supply Company (PESCO), headquartered in Peshawar, offers electricity delivery facilities to more than 2.6 million customers in all of Khyber Pukhtunkhwa. At PESCO through 132 & 66KV sub-transmission lines, sub-stations and as well as with 11KV & 440V low voltage lines along with distribution transformers that carry electricity to your home or company. Through this method, PESCO owns and operates the Khyber Pukhtunkhwa's electricity distribution system. Peshawar Electric Supply Company (PESCO) is well positioned and committed to satisfy its various customers and sustain a steady power supply. PESCO is fragmented into eight zones, comprising a range of approximately 1,204,621 hectares of land. The eight zones in which PESCO operates are Bannu, Khyber, Hazara-1, Hazara-2, Mardan, Swabi and Swat.

Loading Position of 11 KV Feeder						
PESCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% Of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	76,126	77,307	4,070	3,477	5.35	4.50
Loading Position of Power Transformers						
PESCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	243	239	110	86	45.27	35.98
Loading Position of Distribution Transformers						
PESCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	76,126	77,307	4,070	3,477	5.35	4.50

Investment Allowed and Made by PESCO investment in Rs Million						
PESCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	6,549	7,962	7,622	8,366	9,610
	Actual	8,140	5,049	7,622	8,366	11,347

Table 29: Information regarding PESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.9 Multan Electric Power Company (MEPCO)

Multan Electrical Power Company Limited (MEPCO) was established on 14 May 1998 as a public limited company under public policy to unbundle and commercialize Pakistan's power industries. The corporation formed originally to purchase all the resources, privileges, properties, liabilities of the disbanded Multan Area Electricity Board, Grid Stations and Supply System Transmission Lines which were formally under the control of the Multan Area Electricity Board. MEPCO is the nation's largest electricity transmission company operating primarily in 13 Southern Punjab districts which are Multan, D.G. Khan, Lodhran, Layyah, Muzzarrargrah, Bahawalpur, Khanewal, R.Y. Khan, Sahiwal, Pakpattan, Bahawalnagar and Vehari. The company's coverage area is predominantly rural, with a high domestic customer profile and life-line client profile.

Loading Position of 11 KV Feeder						
MEPCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	169,938	178,730	5,673	5,832	3.34	3.26
Loading Position of Power Transformers						
MEPCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	293	302	34	37	11.60	12.25
Loading Position of Distribution Transformers						
MEPCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% of Total Over-loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	169,938	178,730	5,673	5,832	3.34	3.26

Investment Allowed and Made by MEPCO investment in Rs Million						
MEPCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	7,492	8,697	10,546	11,416	13,000
	Actual	7,748	8,503	10,008	11,416	14,924

Table 30: Information regarding MEPCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.2.10 Tribal Electric Supply Company (TESCO)

Tribal Electric Supply Company (TESCO) is a provider of electricity to FATA region of Pakistan. FATA had existed from 1947 up to its merger with the adjacent province of Khyber Pakhtunkhwa in 2018. It was a semi-autonomous tribal zone in north-Western part of Pakistan. It was constituted of seven tribal councils (districts) and six frontier regions. The area of Pakistan was regulated through a specific provision of law known as the Frontier Crimes Regulations, which is strictly controlled by the federal government of Pakistan. TESCO is the sole power distribution company which supplies electricity to consumers in this particular region. TESCO workers were responsible for all the activities of the construction of the transmission line 11 kV and the line 132/66 kV. In addition to that, SS&TL Division Peshawar of TESCO is also liable for its maintenance.

Loading Position of 11 KV Feeder						
TESCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders (Above 80%)		% of Total Over-Loaded 11 kV Feeders (Above 80%)	
	2019	2020	2019	2020	2019	2020
	18,730	18,903	3,977	6,682	21.23	35.35
Loading Position of Power Transformers						
TESCO	Total No of Transformers		Total No of Over-loaded Power Transformers (Above 80%)		% Of Total Over-loaded Power Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	48	55	17	16	35.42	29.09
Loading Position of Distribution Transformers						
TESCO	Total No of Distribution Transformers		Total No of Over-loaded Distribution Transformers (Above 80%)		% Of Total Over-Loaded Distribution Transformers (Above 80%)	
	2019	2020	2019	2020	2019	2020
	18,730	18,903	3,977	6,682	21.23	35.35

Investment Allowed and Made by TESCO investment in Rs Million						
TESCO	Investment	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	Allowed	542	613	1,013	971	770
	Actual	317	367	814	971	744

Table 31: Information regarding TESCO

Data Source: State of Industry Report 2020 - National Electric Power Regulatory Authority Pakistan

4.3 Methodology of Power production

Pakistan is a nation abundantly equipped with all kinds of energy assets that can improve the country's economy effectively. Pakistan's electricity market is regulated directly through either government or numerous private entities. Considering the demand aspect are the largest fields of the industry such as residential, industrial, transportation, transmission, and agriculture while the power generation is generated via oil, coal, LPG, hydropower, and nuclear power. Pakistan's electricity industry consists of three of the main bodies: The Minister of Water and Resources, the Central Regulatory Authority for Electricity, and the Board for Private Power Infrastructure. Apart from that, numerous electricity generation firms and distributors including WAPDA, NTDC, KESC, GENCO and DISCOs work in Pakistan.

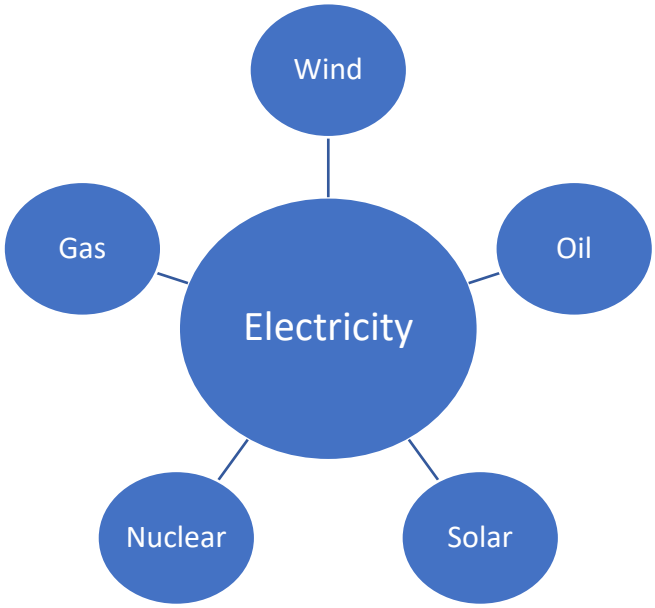
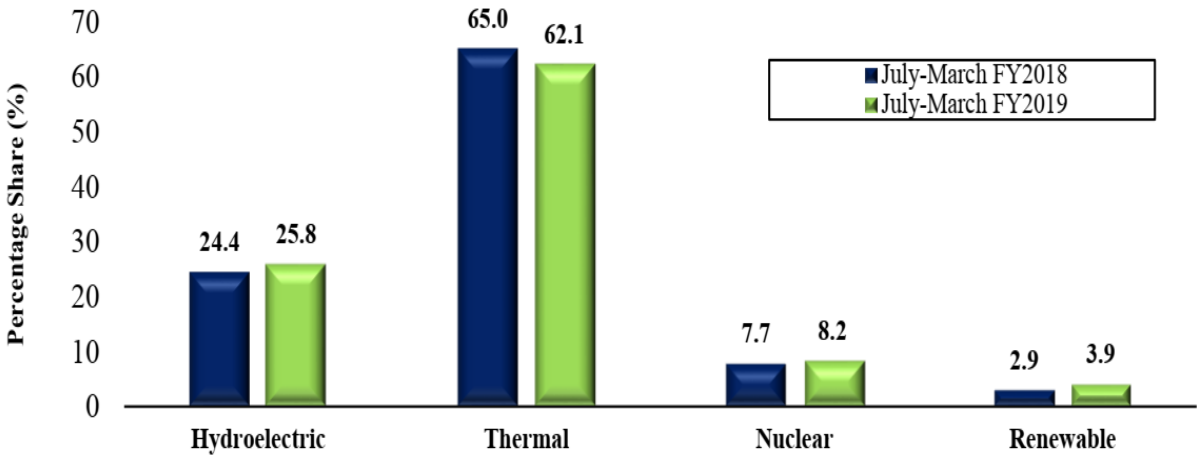


Figure 8: Sources of Electricity

Pakistan's reliance on oil reached 43.5% in FY-1998 and FY-2001 concerning energy blend. Oil dependency for the FY-2018 fell to 31,2%. Correspondingly, hydro was estimated to project to 13.1% in FY-1998, and it was recorded as 7.7% in the fiscal year 2017-2018 [20]. Although the decreasing proportion of oil represents a pleasant message as the national exchequer becomes less burdensome, the decreased share of hydro signifies the lack of ambition as well as the failure of successive governments to undertake such capital-intensive projects promptly.

In the total energy mix in FY-2006, Pakistan's gas dependency hit an all-time peak of 50.4% [37]. Whereas the dependency on gas for the FY-2018 dropped to 34.6% [37]. This decline in energy mix share is due to decreasing natural gas supplies and limited gas usage in the transport sector and LNG induction since 2015. The proportion of LNG imported rose by 0.7% in 2015 towards 8.7% in 2018, which reflects a splendid improvement in the energy balance of the fuel [20]. For the last two decades, the share of coal has stood at a single digit. In FY-2018, however, coal contribution in the energy mix was high by 12.7% [39]. Similarly, in FY2015, the renewable energy proportion was reported to grow progressively to 1.1% FY-2018 from 0.3%. In addition, the nuclear power share in FY-2018 grew gradually to 2.7% in contrast with 0.2% in FY-1997 [32]. The Integrated Energy Strategy was used to devise such a historic variability for each energy supply in the country's energy mix. The comprehensive energy strategy would not only lead to the evaluation of energy needs and future supply routes but also the creation of long-term policy alternatives based on facts.



Graph 11: Portions of Electricity Generation in Pakistan of different sources

Source: Ministry of Energy, Hydrocarbon Development Institute of Pakistan (HDIP)

4.3.1 Hydel

Pakistan is dotted with significant water supplies on the banks of the Indus Valley. There is a capacity of 60,000MW hydropower available in the nation, of whom only 7.320MW have been utilized currently according to the Pakistan Water and Power Development Authority (WAPDA). In the rugged north on the Indus Rivers in Gilgit Baltistan and Khyber Pakhtunkhwa provinces and the Jhelum in Punjab and Azad Jammu, and the Provinces of Kashmir, Pakistan's untapped hydropower capacity lies. Hydroelectricity is perfectly available for resurgence and will have a major role in overcoming the power shortfall of the nation. Some surveys have projected that the hydropower proportion of overall

power generation will increase to over 40% by 2030 in Pakistan [38]. The current government of Pakistan places great focus on exploiting the historically unexploited hydroelectric potential and has relied heavily on international contributions by private companies, foreign governments, and multilateral banks for growth to meet this ambition. In 2016, several hydropower plants, including Ranolia (17 MW), Daral Khwar (37 MW) and Machai (2,6 MW), were completed or commissioned. These projects are mainly situated in the province of Khyber Pakhtunkhwa [37].

As part of an initiative led by the Khyber Pakhtunkhwa administration, several micro-hydropower projects have also been developed to build some 1000 micro-plants, funded by Asian Development Bank. These microprojects with a built total power of 100 MW are intended to provide inexpensive and stable electricity to remote, off-grid communities. Many private sector projects, including Karot (720MW), Suki (870MW) and Kohala, are being supervised by the Board of Private Power & Infrastructure (1,124 MW) [37]. Those projects are part of a series of Chinese Government-supported development projects to reinforce Pakistan's economy and improve trade ties between the two countries.

WAPDA is a national organization that is responsible for the production, maintenance, and control of hydroelectric plants in the Republic of Pakistan. WAPDA produced Hydel energy of 37.425.41 GWh during the Fiscal year of 2019-20 compared to the 31.167.85 GWh in 2010, which indicated a rise of 6.257.56 GWh. During the same span, hydro energy produced through IPPs was about 1.562.55 GWh of electricity in FY 2018-19, which declined to 365.49 GWh in contrast to 1,928.04 GWh [WAPDA]. During the current financial year of 2019-20, the share of hydroelectricity production in the CPPA-G basket stands at 30.77%, and as compared to the previous fiscal year 2018-19 this contribution recorded as 25.35% [20].

S. No	Name of Project	Installed Capacity (MW)	S. No	Name of Project	Installed Capacity (MW)
1	Tarbela	3478	11	Nandipur	13.8
2	Ghazi Barotha	1450	12	Kurram Gari	4
3	Mangla	1000	13	Reshun	2.8
4	Warsak	240	14	Renala	1.1
5	Chashma	184	15	Chitral	1
6	Malakand	19.6	16	Jagran-I	30.4
7	Dargai	20	17	Kathai	1.6

8	Rasul	22	18	Kundel Shahi	2
9	Shadiwal	13.5	19	Leepa	1.6
10	Chichoki Malian	13.2	20	Northern Area	94

Table 32: Existing Hydel Power Stations in Pakistan

Data Source: Water and Power Development Authority Pakistan

Name of Province	Projects in Operation (MW)	Public sector Projects (MW)	Private sector Projects (MW)	Projects with Feasibility Study (MW)		Projects with Pre-Feasibility Study/ Raw Sites (MW)	
				Above 50 MW	Below 50 MW	Above 50 MW	Below 50 MW
NWFP	3767.2	635	84	58	143	13584	426
Punjab	1698	96	Nil	3720	32.17	NIL	349.65
AJK	1036.1	973.8	828.7	420	48.2	1152	177
Northern Areas	93.732	18	Nil	505	71.5	10905	814
Sindh	Nil	Nil	Nil	Nil	49.5	80	48.55
Baluchistan	Nil	Nil	Nil	Nil	0.5	Nil	Nil
TOTAL	6595.032	1722.8	912.7	4703	344.87	25721	1815.

Table 33: Comparative Summary of the Hydel Projects in Various Stages of Implementation in Various Regions of Pakistan

Data Source: Water and Power Development Authority Pakistan

4.3.2 Oil

To meet energy requirements, Pakistan primarily relies on oil. National crude oil maximum output probably stood at 24.6 million barrels between July and March of the FY-2019 in contrast to 21.8 million barrels during the same period of the previous year [20]. Domestic oil supplies are not adequate to quench the thirst for energy in a developing country. Consequently, Pakistan requires to purchase large quantities of oil and other petroleum commodities, particularly from Saudi Arabia and other Middle Eastern countries. The quantity of crude oil purchased managed to amounted to 6.6 million tonnes with a capital of US$ 3.4 billion throughout the current fiscal year, contrary to 7.8 million tonnes with a valuation of US$ 2.9 billion in the corresponding span of the previous year [20]. The decrease was attributed largely to the rise of international prices. The deferred payment of purchased Oil from the Middle Eastern countries would facilitate the balance of payments by lowering the pressure of paying oil bills to whom oil is imported. The two main uses of oil in Pakistan are transport and electricity production. Oil usage in transport purposes rose from 56% during the same period last year to 77% in the current year and oil energy consumption fell to 14% which was 25% during the same period last year [39]. Gas is mainly the cheapest source, and the energy market is constantly switching from oil to gas.

There are six large and two small refineries to process the indigenous and imported oil in the country. In Hub Balochistan, the Byco Petroleum Pakistan Limited (BPPL) operates a 120,000 barrel per day oil

refining facility with a production cost of 400 million dollars [40]. The refinery has a 5 million tons annual capacity. Byco has also set up Single Buoy Mooring (SBM), which transports imported petroleum products from shipping ports to refineries. This facility has a technical capacity of 12 million tons in a year. In addition, another refinery that operates in a country is Attock Refinery Limited (ARL) which successfully had built an isomerization station. Furthermore, the refinery has begun processing Euro-II (0.05% Sulfur HSD) in a country. In 2016 also the isomerization plant was established by Pakistan Refinery Limited (PRL), which since then refinery doubled its gasoline output [41]. In an addition, Pak Arab Refinery Limited (PARCO), a state-of-the-art refinery with a production ability of 250,000 barrels per daily. The refinery is delivering the PARCO Coastal Refinery project at Khalifa Point near Hub, Baluchistan over 11 million tons per annum. The project cost is projected at more than US$ 5 billion [40].

Name of Power Stations	Location	Capacity (MW)
Kot Addu Power Company	Punjab	1600
Hub Power Company	Balochistan	1,292
Hubco Narowal Power Plant	Punjab	225
Gul Ahmed Energy	Sindh	136
Nishat Power Ltd	Punjab	200
Nishat Chunian Power Ltd	Punjab	200
Saba Power Company Ltd	Punjab	125
Southern Electric Power Company Ltd	Punjab	136
Tapal Energy Ltd	Balochistan	126
Japan Power Generation Pvt Ltd	Punjab	135
Kohinoor Energy Ltd	Punjab	131
Liberty Power Tech	Punjab	200
AES Lal Pir Power	Punjab	362
AES PakGen	Punjab	365
Attock Group Attock Gen Ltd.	Punjab	165
Jamshoro Power Station	Sindh	850
K-Electric Bin Qasim Power Plant	Sindh	1,26
Sitara Energy Ltd	Punjab	85

Attock Refinery Ltd	Punjab	18
Atlas Power Ltd	Punjab	225

Table 34: Power Generation Stations in Pakistan

Data Source: Water and Power Development Authority Pakistan

Name of Refinery	Capacity	Area
Pak Arab Refinery Limited (MCR)	100,000 bbl/d	Multan
Attock Refinery Limited (ARL)	53,400bbl/d	Rawalpindi
Byco Petroleum Pakistan Ltd (Byco)	150,000bbl/d	Hub Balochistan
National Refinery Limited (NRL)	64,000bbl/d	Karachi
Pakistan Refinery Limited (PRL)	50,000bbl/d	Karachi

Table 35: Oil Refineries in Pakistan

Data Source: Oil and Gas Development Company Pakistan

4.3.3 Natural Gas

Natural Gas is an environmentally friendly, safe, and reliable fuel. Its native supplies make up roughly 38% of the country's overall primary supply mix. Pakistan has a comprehensive gas infrastructure of more than 12,971 km [37]. The transmission is 139,827 km and the distribution of gas pipelines the 37,058 km. Pakistan's government has been promoting policies to maximize the supply of domestic gas and import gas to meet the country's rising energy demand [40]. Currently, the maximum capability of Floating Liquefied Natural Gas Storage and Regasification Units (FLRUs) has been about 1200 MMCFD [31]. Resultantly, the RLNG has been purchased from foreign countries to minimize the market supply gap. The aggregate usage of natural gas (MMCFD) amounted to about 3,865 million cubic feet per day between July 2018 to February 2019. At the same time, the two Gas Supply Enterprises, the SNGPL and the SSGCL have built a network of 69kilometress along with a distribution system of 3232 kilometres and service lines of 1.366 kilometres to connect new 165 towns and villages to the gas grid system of the country [20].

During the year 2019-20, gas produced a total of 20 615.48 GWh of electricity particularly in comparison with 28.010.55 GWh in the fiscal year 2018-19. In the fiscal year of 2019-20, the gas-based generation in NTDC was 15,236,30 GWh while in KE is about 5,379,18 GWh [40]. In a total thermal generation, the proportion of electricity produced by gas in the 2019-20 financial year was 25.28% while in the 2017-18 and 2018-19 fiscal years the share in electricity generated by gas stood at 32.24%

and 31.33% [42]. As compared to the price of the RLNG, the price of MMBTU gas is much lower. Furthermore, in some of GENCO and KE's less effective power plants, high-quality pipeline gas is being used. By allocating cheaper gas fuel to such less productive power stations, the cost of power generation can be reduced.

In addition to that, the RLNG electricity generated in FY 2019-20 was 26,816,08 GWh compared to 30,813,32 GWh a decrease of 3,997,24 GWh in FY 2018-19. In NTDC, 23,830 GWh and 2,985,50 GWh in the KE region electricity were produced through RLNG using as a fuel [20]. During 2019-20, the share of the RLNG based thermal generation in total thermal generation remained 32.88%, compared with 23.01% and 34.47% in FY 2017-18 and FY 2018-19 [40].

			2015-16	2016-17	2017-18	2018-19	2019-20
Coal	CPPA-G System*	Generation on Gas (GWh)	29,497.42	31,520.24	23,291.97	22,439.40	15,236.30
		Share of Gas Generation (%)	40.04	39.99	25.31	25.10	18.68
	KE System**	Generation on Gas (GWh)	8,065.00	6,768.50	6,374.93	5,571.15	5,379.18
		Share of Gas Generation (%)	10.95	8.59	6.93	6.23	6.60
	Total	Generation on Gas (GWh)	37,562.42	38,288.74	29,666.90	28,010.55	20,615.48
		Share of Gas Generation (%)	50.99	48.58	32.24	31.33	25.28
RLNG	CPPA-G System	Generation on Gas (GWh)	0.00	657.88	20,678.32	28,148.92	23,830.58
		Share of Gas Generation (%)	0.00	0.83	22.47	31.49	29.22
	KE System	Generation on Gas (GWh)	0.00	0.00	496.34	2,664.40	2,985.50
		Share of Gas Generation (%)	0.00	0.00	0.54	2.98	3.66
	Total	Generation on Gas (GWh)	0.00	657.88	21,174.66	30,813.32	26,816.08

	Share of Gas Generation (%)	0.00	0.83	23.01	34.47	32.88
* Including generation of SPPs/CPPs/N-CPPs in CPPA-G System. ** Including generation of IPPs in KE System						

Table 36: Power Generation through coal in Pakistan from 2015 to 2020

Data Source: National Electric Power Regulatory Authority of Pakistan

4.3.4 Coal

In terms of coal wealth, Pakistan is the 6th richest nation in the world. The presence of coal deposits in Pakistan was not recognized at the time of independence. These deposits were not officially acknowledged, but their economic importance came to light in 1980. This occurred when massive deposits of coal were found in the Lakhra and Sonda areas of Sindh Province. Not only in Sindh but also in all the four provinces and AJK, abundant coal reserves have been discovered. Pakistan's coal reserves are valued at over 186 billion tons, among whom approximately 175 billion tons have been found in the Thar coalfields [39].

In general, Pakistan's coal ranges from lignite to sub-bituminous. Thar coal has an immense source, but it has a relatively low thermal efficiency ranges between 6223 to 10,288 Btu/lb [39]. Moreover, the thickness of the seams of Thar coal which is ranges from 0.25–12.58 m that seems to be uneconomical in general usage [37]. Therefore, nearly about 4 million tons of coal is being imported from foreign countries to satisfy local demand. There are about 3752, 244 and 106 million tons of coal and a high degree of geological assurance in the three largest reserves, namely Thar, Lakhra and Jherruck.

In FY 2019-20, total power produced in coal amounted to 25,966.40 GWh in 2018-19 compared with 16,725.46 GWh, an increase of 9,240.40 GWh in the fiscal year 2014-10 [20]. The electricity production from coal in NTDC was 25,553,40 GWh and in KE it was 413 GWh. In 2019-20, the share of coal-based power output in total thermal generation stood at 31.84 per cent, compared with 13.29% and 18.71% in FY 2017-18 and FY 2018-19 [39]. Coal power installations remained at approximately 66% of the installed coal-fired power plant capacity during the 2019-20 fiscal year [40].

Name of Power Stations	Location	Capacity (MW)
Master power pvt Limited	Punjab	20

Sitara Chemical Industries Ltd	Punjab	40
Fauji Fertilizer Power Plant	Sindh	118
Sahiwal Coal Power Project	Punjab	1320
Maple Leaf Power Ltd	Punjab	40
Port Qasim Coal Power Project	Sindh	1320
DG Cement Coal Power Project	Punjab	30
Hub Coal Power Project	Balochistan	1320
Engro Powergen Thar	Sindh	660

Table 37: Power Generation units Powered through Coal

Data Source: Water and Power Development Authority Pakistan

4.3.5 Solar and Wind

Pakistan is ideally situated in the sunbelt to benefit from solar power technology. This source of energy is widespread in the country and readily available. The global average horizontal surface irradiation in Pakistan is approx. 200–250 watts per m2 per day, and approx. 1500–3000 hours of sunshine per year [33]. Baluchistan's southwest province is especially rich in solar power. The average global sunshine of the sun is between 19-20 MJ/m2, with annual mean sunshine of 8–8.5 hours, per year (1.93-2.03 MWh for each m2/year) [34]. These conditions are suitable for solar energy applications, photovoltaics (PV). In accordance with the above-listed estimates, the Energy Information Administration defines Pakistan's daily solar energy capacity as 5,3 kWh (1.93 MWh per m2) per m2 [30].

According to the NREL USA study report, Pakistan has an immense amount of wind energy capacity for generation of about 346 GW. The wind speed is approximately 5–12 m/s in the region of the Sindh Wind Corridor [35]. Pakistan has a Sindh coastal line with ample wind power sources of up to 20 GW of power. Renewable energy has immense potential at a global level and can respond to the global power mandate. The world should increase energy sources on the markets, have stable, long periods of viable energy supply, and reduce global atmospheric conditions. It offers commercially intelligent opportunities, in particular for rural areas and emerging regions. However, wind capacity is used properly only for electricity generation in the Sindh province and can fulfil the country's electric crisis mandate.

The total produced electricity for the WPPs was 2.882 GWh for the fiscal year 2019-20 compared to 3.231,64 GWh, which was a fall to 349,64 GWh for the fiscal period 2018-19 [32]. Of this 1,248 MW

wind energy, KE has purchased electricity from three power stations which include Zephyr Power, Tenaga Generasi and Hydro China Dawood. This power purchase has been occurring due to the agency agreement between KE, CPPA-G and NTDC. Throughout the current year 2020, KE has received about 423 GWh of electricity from these three WPPs. However, the total power generation in NTDC-connected Solar Power Projects in 2019-20 was 704,97 GWh compared to 714,52 GWh in 2018-19, a decline of 9,55 GWh [40].

Solar Power Projects		
Name of Power Stations	Location	Capacity (MW)
Quaid-e-Azam Solar Park	Punjab	400
OurSun Solar Power Plant	Sindh	50
Gharo Solar Power Plant	Sindh	50
Harappa Solar Pvt. Ltd	Punjab	18
AJ Power Pvt. Ltd.	Punjab	12
Eni Bhit Solar	Sindh	10
Wind Power Projects		
Name of Power Stations	Location	Capacity (MW)
FFC Energy Wind Project	Sindh	49.5
Zorlu Enerji Pakistan	Sindh	56.4
Three Gorges Pvt Ltd	Sindh	150
Foundation Wind Energy Pvt Ltd	Sindh	100
Sapphire Wind Power Pvt Ltd	Sindh	52.8
Yunus Energy Ltd	Sindh	50
Metro Wind Power Co Ltd	Sindh	50
Tenaga Generai Ltd	Sindh	49.5
Gul Ahmed Wind Power Ltd	Sindh	50
Master Wind Energy Ltd	Sindh	52.8
ACT Wind Pvt Ltd	Sindh	30
HydroChina Dawood Wind Power Project	Sindh	50
Sachal Energy Wind Farm	Sindh	50
United Energy Pakistan Wind Ltd	Sindh	100
Hawa Energy Ltd	Sindh	50
Burj Capital Jhimpir Wind Power Limited	Sindh	50
Artistic Energy Pvt. Ltd	Sindh	49.3

Tricon Boston Corporation	Sindh	150
Zephyr Power Ltd	Sindh	50

Table 38: Solar and Wind Power Generation Units of Pakistan

Data Source: Water and Power Development Authority Pakistan

4.3.6 Nuclear

Pakistan has a total capacity of 1.3 GW, five small nuclear reactor operations [41]. There are two new construction works of nuclear power plants that are underway for 2,2 GW in total and will run on the budget in 2020 and 2021 [20]. Pakistan's nuclear power unit building times ranged from 5.2 to 5.6 years. Nevertheless, the long delays that most major nuclear plant builds worldwide have been recorded by IEEFA for several years. The Pakistan Atomic Energy Commission (PAEC) signed a collaboration agreement with the Chinese National Nuclear Corporation (CNNC) to construct a second unit of Pakistan's third HPR1000 reactor type One. This project will be China's built seventh-largest reactor. Further feasibility proposals are also available to Pakistan's Atomic Energy Board, aimed at reaching nearly 9 GW of nuclear power by 2030. At a time when nuclear power is declining globally, Pakistan is constructing more nuclear power units. Outside China, for the third consecutive year, global nuclear power output declined. In 2017 only four new reactors were launched, three in China and one four in Pakistan, designed by the Chinese. Since 2016 there has been no new building of commercial reactors in China.

The International Atomic Energy Agency (IAEA) cites the latest energy, electricity, and nuclear energy budget as a source of overlap in nuclear power outlook, as well as the effect of renewable energy technologies on electricity prices. The timeframe needed for the completion of nuclear reactors has been highly unpredictable after years of gradually increasing construction, with longevity in some instances exceeding 10 years. The IAEA attributes higher safety norms as well as difficulty in introducing new nuclear technologies to the rise in construction time.

The Pakistan Atomic Energy Commission (PAEC) manages nuclear power output, which undertakes all development, execution, operation, and maintenance of nuclear power. In the current fiscal year 2019-20, all four NPPs connected to the NTDC system produced 9,704,89GWh compared to 9,005,68 GWh in the previous fiscal year 2018-19, which was an increase of 699,21GWh [40].

Plant	**Capacity (MW)**		**Electricity sent to Grid (Million KWH)**	
	Gross	**Net**	**1st July 2019 to 31st March 2020**	**Lifetime up to 31st March 2020**

KANUPP	100	90	119	14,649
C-1	325	300	1,391	39,160
C-2	325	300	1,966	20,192
C-3	340	315	1,643	7,951
C-4	340	315	2,024	5,907
Total	**1430**	**1320**	**7,143**	**87,859**

Table 39: Nuclear power Plant in Pakistan

Data Source: Pakistan Atomic Energy Commission

4.4 Factors responsible for lack of energy access

The energy crisis which Pakistan is facing today is due to the number of factors. These factors are described as under in detail to under the how such factors affecting the power industry of Pakistan and reasons why such factors occur in the country.

4.4.1 Inadequate installation capacity and inefficient Power Generation Plants

The GENCO plants have degraded their productivity over time. In addition, these GENCOs have also decreased to lower limits due to low performance. During the fiscal year 2019-20, the overall GENCO production was 7,907.91 GWh, slightly less than the previous year's 13,016.93 GWh generation [42]. Of the 7 907,91 GWh, two power stations i.e., GENCO-747 II's MW CCPP and GENCO-567 III's MW TPS Guddu produced 5,791,68 GWh combined while the remaining GENCO power stations only generated 2 16,23 GWh with a capacity of 3,539 MW. For the second consecutive year, GENCO-IV registered zero generation [37].

GENCO's poor performance leads to unsuccessful fuel burning and higher generating costs. As GENCO II and III are focused on "take or pay" tariffs, their low use on the one hand, on account of the idle capacity payment, burdens electricity consumers. On the other hand, because of their low productivity, the use of GENCOs' older plants raises the cost of growing a Central Power Purchasing Agency (CPPA-G) basket. In addition, the partial load activity of these power plants qualifies them for partial load adaptation charges (PLACs), which also adversely affect electricity costs. The CPPA-G has tested the figure accordingly for the fiscal year 2019-20 for Rs. 177.79 million with Rs. 157.35 million and for the fiscal year 2019-20 Rs. 894.87 million for the CPPA-G and GENCO-III for the FY 2018-19 and Rs. 431.23 million for the CPPA-G [20].

The inefficient operation of GENCO power stations is a continual burden on the nation. Retaining the old obsolete steam thermal power plants when it has enough power plants that are also not attractive on a 'take or pay basis. The control duration decided by NEPRA is not too long for GENCOs as opposed to IPPs. To reduce the financial strain of the industry, and to move valuable fuel to the most productive power stations, NEPRA has repeatedly stressed the need to remove GENCOs' older power stations.

4.4.2 Improper Management of Electric Power Demand

Throughout the daytime including in summer and winter, there was a large difference between peak load and off-peak load. It is indeed a real challenge in the context of the "take or pay" obligation, which raises the obligation of electricity accessibility and final energy costs, to hold the generating capacity to meet full demand at all stages. The difference between peak and off-peak requirements of the network must therefore be reduced. With an emphasis on controlling electricity supply, demand-side management appears to be omitted from the preferences.

Efficient energy-saving initiatives and creative approaches such as intelligent metering, time-of-use (TOU) charging (hourly, worktime, not-for-work days and periodic) remotely controlled systems, the incentive of off-peak energy and sustainable usage awareness campaign among consumers in peak hours, etc., might be used to manage consumption. TOU tariff may also be used for energy advertising as well as discouraging with an in-depth analysis of charging demand trends.

Successful demand front management would then further mitigate the necessity for energy investment and allow affordable electricity accessible throughout peak season to the major industries, especially manufacturing sector companies. The economic growth in the nation can indeed be improved by successful Demand Front Control strategies.

4.4.3 Ineffective sharing system of electricity among NTDC and K-Electric

In late 2008, NTDC has been agreed upon the framework of a similar pathway as authorised for EX-WAPDA DISCOs, to process the KESC (currently called as K-Electric) in parallel with the Ex-WAPDA DISCO for the activities of electricity trading. KE began receiving an average of 650 MW of electricity from NTDC [40]. There have been currently numerous IPPs, with a potential of over 3,500 MW, installed on the KE region, providing CPPA-G basket electricity [43]. Furthermore, because of whether less system demand and/or limitations in the transmission system, the take-off or the paying potential for even effective power stations providing CPPA-G basket electricity is not completely exploited.

Around the present moment, KE has been often insufficient to satisfy market demand, or its production expense is significantly greater than that of CPPA-idle G's power. Where CPPA-G is extremely low and KE needs less expensive energy, KE and CPPA-G are permitted to conclude a cooperative agreement where CPPA-G can provide KE with supplementary electricity based on the rates and requirements permitted by NEPRA. Nevertheless, considering the accessibility of affordable electricity in the CPPA-G basket, KE is not able to produce or purchase relatively more expensive electricity for domains domain to satisfy the requirements and this is an insufficient network for electricity transmission among the KE and the NTDC. In recent times the term of the RFO-based 126 MW Tapal Energy and RFO-based 136 MW Gul Ahmed Energy Generation Licenses was renewed the ed and the rate for the PPA expansion with KE have now been authorized. While the fuel rate portion for Port-Qasim Power Plant and China Power Hub coal-fired power plants on the turf of KE is less than RFO-based Tapal Energy and Gul Ahmed Energy, the electricity produced by Port-Qasim and China Power Hub has been delivered to KE owing to shortage of an interconnected transmission network.

The network which is able to transmit electric energy to a maximum capacity of 2,000 MW should be accessible in addition to promote the transmission of CPPA-G to KE [37]. This network would not only greatly boost the efficiency of both systems but also harness the performance of the whole framework of the system.

4.4.4 Distribution and Line Losses

A stable and effective transmission system is important for the continuity of the electricity supply as well as for the most efficient power stations located in different regions in compliance with the Economic Merit Order (EMO). One key reason for underutilizing the powerful power plants when running the expensive power plants was that there were limitations on transmission and distribution networks, such as transmission overload, inadequate transition capability of electricity transformers, power lines faults, defective transformers and so on.

Over the past five years, both traditional and renewable energy have been induced by new power plants. The PPAs/EPAs standard lays down the obligation for both the buyer and seller to build their respective interconnection facilities, the timetable for completion and the penalty if the agreed timeframes are not met. The NTDC is responsible for developing the process of planning under the Grid Code, which contributes to proposals for particular reinforcing, updating and expansion projects. In most instances, however, interconnection schemes may not be accomplished in accordance with the model and deadlines of different power plants including wind power plants in Jhampir and Gharo.

The Southern network cannot complete the connectivity between 1,320 MW China Power Hub Power Company Limited (CPHGCL) and the power station was working on an interim basis. The North, likewise, was also interim served by the 147 MW Patrin Hydro Power Project and could not construct its interconnection facilities in due course.

The ongoing problems with the transmission line indicate a lack of comprehensive preparation and the urgency of upgrading and extending the transmission network to consolidate the available energy and making effective adoption of the electricity production options available. Immediate action is needed to resolve the inadequacy of the transmission and distribution network, resulting in loss to the power sector and a rising customer burden. The production facilities are scattered throughout the nation, including from north to south. A comprehensive National Grid system is therefore needed; it should be adequately sufficient for transporting the highest possible cheaper electricity from generating facilities anywhere around the country and smoothly transmitting electricity to load centres. In addition, measures are needed to eliminate device restrictions to ensure that the most productive power plants run continuously at full capacity.

In power generation systems, transmission and distribution losses are not rare, but losses beyond reasonable limits unnecessarily escalate the price of electricity for customers. With the appropriate engineering layout of the distribution system and its operation as per pragmatic engineering practices, the T&D losses could be reduced. The double-digit losses of certain DISCOs are a primary challenge, and the corresponding DISCOs must be supervised. While few DISCOs such as IESCO, GEPCO and FESCO had also experienced single-digit T&D losses, the loss rate requires to be examined in accordance with the size of the sales in order to understand the number of losses, and measures must continue to minimize the percentage of losses even farther.

4.4.5 Circular Debt

On behalf of EX-WAPDA DISCOs, CPPA-G is responsible for electricity procurement. The distribution firm, i.e., NTDC buys electric energy from generating firms for DISCO's supply. CPPA-G also provides KE with electricity. CPPA-G improves invoices of power supplies to all distribution companies but also the usage of the transmission company's device charges. In order to allow CPPA-G to make payments to the generation and transmitting companies, distribution companies are obliged to pay the outstanding payments for CPPA- G within a certain duration. Nevertheless, mostly transmission companies cannot make pay-out within the time constraints to CPPA-G, therefore, it failed to make payments to generation and transmission companies. The reasons for distribution companies failed

to provide payments that include higher T&D losses, low recoveries, and so on. The cycle persists because companies cannot pay the fuel suppliers, whose import bill is difficult to pay, which is creating a circular debt phenomenon. The PPAs have marks and increasing financial responsibility for postponement of payments to power companies.

Circular debt accumulation is a grave problem facing the power industry and the state as a whole. Not only it affects fuel supplier, production, transmission, and distribution companies' liquidity, but also raises the price to end-users of electricity. According to CPPA-G, the amount accrued by 30 June 2020 was Rs. 2.150,424 million due to circular power sector debt [source- cppa.gov.pk].

4.4.6 Expensive furnace oil energy production

The socioeconomic and developmental well-being of a nation is highly dependent on accessibility by all sections of the community to sustainable electricity. The accessibility and indiscriminate access to electricity to all at reasonable rates is a characteristic of a productive energy market. In Pakistan, owing to the unavailability of adequate inexpensive electricity production and inadequate transmission and distribution systems, much of the current decade has been plagued by excessive load shedding. Although the electricity supply has dramatically enhanced during the past several years with the installation of considerable power generation units, the price of electricity for final users have been increased due to numerous factors such as higher T&D losses, low recovery, circular debt, large capacity payments, currency devaluation, fuel prices, under-use of productive power stations, etc. The current circumstance demonstrates an absence of a structured strategy for the preparation and execution of the modernization of the power industry and demands for the identification and resolution of the fundamental problems relating to the system's shortfalls.

The taxes for fuel which is used for the production of electricity raises the generation costs, which have a negative effect on the entire economy. While the enforcement of levies tends to elevate revenues, resultantly, it elevates the expenses of producing electricity, which hurts the economy of Pakistan. For sustainable economic development, the sustainability of electricity is necessary. In international markets, the competitiveness of the country's manufacturing sector largely relies on the cost of electricity. It is recognized that the participation of the manufacturing industry in Pakistan's overall power consumption has been decreased over time. The manufacturing sector's contribution recorded 26.47% in the 2015-16 fiscal year, whereas the contribution reached 22.88% in 2019-18 [20]. For a growing nation, this is unprecedented and demands engagement of all concerned stakeholders. In the wider economic context, a pragmatic strategy is therefore needed when the taxes on principal

and final energy resources were imposed. The reduction in turnover from levies, charges and fuel surcharges can be offset by the development of the economy because energy prices are affordable.

4.5 Dire Consequences of energy chaos on economy

The demand for energy with respect to supply in this globalized era is enormously continuing to grow; this culminated in an energy shortage. Most countries are experiencing energy shortages, and as a result, their economic development and social transition are badly affected. Some several views and theories may connect energy to economic development. Energy is seen as the cornerstone of every economy and assumes an essential part in a country's socio-economic growth. Unless energy would be enough, there will be no industrialization, which is key to operating factories and production units, for commercial and residual use, and transportation, etc. Although energy proliferation is supposed to lead to better development, the growth phase will be held back by its scarcity. In short, energy is essential in handling the energy shortage and resource sectors such as agriculture manufacturing, unemployment, poverty, lower GDP and higher inflation. Sadly, Pakistan has been confronted throughout its existence with the worst energy crisis. Pakistan, like several other emerging economies, is among the energy-intensive rising economies. Just like in many non-Oil-producing nations, its fuel requirements are fulfilled with huge volumes of oil imports.

Pakistan's framework for energy is not adequately equipped and stated to be improperly handled. No significant energy production initiatives have been taken despite population expansion, economic development, and growing demand over the last few years. The condition has deteriorated because of obsolete infrastructure, theft of electricity and transmission losses. The current political, financial and energy crises have seriously disrupted Pakistan's development, fiscal, industrial, and trade activities. The continued closure of the industry would result in unemployment and roadblocking. In other nations, the government supports the industry with various incentives for improving production, exports, and competitiveness among the international market. But the majority of enterprises in Pakistan do not have self-satisfaction and they are also afflicted by intense taxation and expensive power supplies, with persistent disruptive effects which lead to the loss in outputs of the textile industry, particularly in textiles whose exports are confined to a quite lower scale, and which are completely closed down or move towards the neighbouring countries.

4.5.1 Economic Recession

As Pakistan is a growing economy. Therefore, energy sustainability plays a major role in its path of becoming a developed nation. Unfortunately, due to the ongoing crisis of energy shortage in the country which Pakistan is facing since its independence is not allowing the country to perform better. Resultantly, the industrial, agricultural, and service sectors of the economy are suffering a lot. The recession is a major economic downturn, which lasts more than a couple of months or years and is usually evident in real GDP, real wages, unemployment, industrial production, and wholesale-retail sales. The recession in Pakistan is noticeable in the nation's manufacturing output, jobs rate, real income, and wholesale trade. Industries are continuously shutting down. They are not getting the required power supply. Resultantly, industries cannot fulfil their customers' orders on time. Along with this, they must pay a large sum of money for electricity bills like the electricity in Pakistan is being produced mainly through furnace oil which is the most expensive method of producing electricity. Consequently, their competitiveness in the international market is good for nothing.

As far as the agricultural sector is concerned, it is also bearing the brunt of the energy crisis. As we know that, Pakistan is an agrion economy. The agricultural sector is the backbone of the economy of Pakistan. Agri production is electricity intensive as a result of groundwater pumping, and energy consumption seems to be increasing; energy scarcity, therefore, has damaging consequences on farming. Groundwater pumping utilizes the most electricity in the growing crops especially in Pakistan's Punjab Province and was accounted for about roughly 61% of the utilization of agricultural overall demand of electricity. With an 80% rise in frequency of electricity consumption for agricultural applications in recent decades and just 31% of crop production, growing crops for farmers particularly in the rural areas, where electricity load shedding occurs about 10 to 12 hours a day, is too difficult. This leads to a reduction in agricultural output and may cause food insecurity in the country. Taking into consideration that accessibility of adequate water and energy is important for the optimization of people's health in Pakistan, political motivations and strategies should be geared towards the appropriate utilization and conservation of natural resources. The indiscriminate use and abuse of natural and environmental resources risk humanity's livelihood and well-being.

Energy demand is anticipated to significantly boost, and economic growth may be slowed down by its scarcity. As a third fundamental supply, energy boosts production and increases the performance of other variables such as labour and capital. The energy thus has significant and unintended paths influencing the level of investment in output, revenue, and employment. The energy shortage in Pakistan continued to play a role in reducing investment activities and reducing baseline performance.

In the recessionary period of international economies, Pakistan also experienced extremely cold and bitter consequences, largely because of oil fluctuations. The current account deficit and the debt problem had been aggravated because of the importing oil due to the price unstableness of petroleum products in the international market. That's why the energy crisis is therefore interlinked with the ongoing economic and global financial crisis as well as a rising global trend.

4.5.2 Deindustrialization

The word deindustrialization corresponds to socio-economic shifts that are triggered by a decline in industrial ability or by the loss of the economy's production capacity. Pakistan's economy was being confronted with contradictory industrial policies, liberalization reforms and macro-economic problems in terms of energy crisis and uncertainty. Since about the nineties, the nation seems to be under deindustrialization and attempts are in vain to revive the industry.

The severe energy crisis appears to worsen and government problems with independent power producers (IPPs) have severely impacted the electricity production and distribution capability of the sector. Throughout this relation, the under-optimal de-industrialization in Pakistan has been linked to the energy crisis, which prevented the industry from operating at its capacity and thus reduced production growth. Another factor in threatening productivity can be called consistent declines in the economic growth capabilities and the internal energy shortages and an unsustainable increase in electricity prices. Regarding the role of the energy crisis in impeding industrial sector development, efforts have been made to quantitatively analyse how much important is the energy component in this crisis and the part played by energy shortages in deindustrializing Pakistan. The significant elements deciding the time course of the industrial sector's GDP portion are electricity production and unpredictable electricity usage by industry alongside household consumption and inflation and energy imports.

The electricity catastrophe in Pakistan may have been the one variable that seemed to have a significant effect on the industry and the economy as a whole. It was projected that 2 to 3% of GDP per year was decreased as a result of power shortages. Whereas electricity seems to have a significant role in many of these economic activities, although some sectors – such as textiles and power looms – have suffered the consequences of the energy crisis to the great extent.

As the Asian Development Bank, published in a report at the start of 2012, found that the lack of energy is a major obstacle to economic progress and recommended effective electricity load management to reduce economic losses [11]. The ADB projected that the Growth rate decreased by

about 3% to 4% due to the oil and gas scarcity in the country [11]. Improved power resource management will improve the situation of load-shedding and minimize costs of production for the private sector. In the evaluation of the Pakistani manufacturing sector, the economic expert Abid Burki and his colleagues suggest that Pakistan's manufacturing industry and economy are impacted by the current energy crisis. A rough calculation places industry loss of 13% or almost Rs 130 billion a year of total industry revenue [23]. The energy meltdown affects the industry on many levels like rises in energy tariffs that are forcing narrow profit companies and those that are small industries that cannot produce their electricity on their own are facing the crisis to shut down; uninformed load-shedding and voltage fluctuations are causing thousands of dollars destruction to machinery production capacity; lack of availability of electricity is damaging the labour productivity of related industries.

4.5.3 Unemployment

Pakistan has been traumatized for a long time by the severe energy shortage. There are several energy sources in Pakistan but the country plunges into darkness for almost 24 hours due to a lack of preparation and directed efforts. Both residential and industrial areas in Pakistan are unable to provide electricity. If electricity and gas are not available to operate the factories, oil is not sufficiently available for transport and how can earth-enabled factories create jobs? These companies and factories are therefore relocating to other Asian countries such as Bangladesh, India and Sri Lanka. As a consequence, a vast number of jobs have been exposed to the unemployment plague.

Unemployment could be the most complicated issue in Pakistan. Irrespective of the initiatives followed to examine Pakistan's unique problems today, one thing is certainly real, namely the shortage of jobs. Whether it is violence, health, or political upheaval, the buck ends at unemployment. While successive Pakistani governments have taken policies to resolve the problem, our nation has still been troubled by the dilemma. And indeed, the key cause for this problem is that previous administrations have taken a strategy that too often is influenced by many shortcomings and gaps, at such a period when it is experiencing a growing economy and a host of governments' programs. The situation now is that the problem has gone so far that even professionally intelligent citizens turn to abhorrent activities, such as extortion and challenging to achieve both purposes because they are unable to secure jobs. In their considerations to fulfil their basic needs of life, there is no other way, and they opt for such illegal ways of earning bread.

The current federal administration also makes a major error when it wants to build jobs without understanding that dumping money into problems doesn't correct them. Consider, for example, the

funds allocated throughout the previous years for various projects, including the Benazir Income Support Program and the Youth Business Loans for Prime Ministers. The administration begins with generating employment in each scenario and ends up making a massive bureaucracy which finally concludes with the government spending money on political favours.

Unemployment is a serious problem. To overcome this crisis, the Pakistani government must take this problem seriously and must come with productive and efficient strategies. We need to reconsider our higher education policy and understand that not everyone will benefit. Many citizens are more appropriate than easily replaceable cookies cutter graduates for professional instruction, which lets them get real work. Technical education is attracting considerable attention and investment in Germany, France, Canada, and other developed countries that create sustainable employment and even open up new entrepreneurial opportunities for technical institutes students. Furthermore, the government needs to overcome the energy crisis, so, the industries which are closing down and moving to foreign countries, could be facilized and they can operate in the country without any difficulties.

4.5.4 Reduction in Foreign Direct Investment

The most required capital funds, advanced production methods, snobbish management skills, advertising and marketing experience, global ties and the hotly contested price transfer phenomenon are supported by FDI. Pakistan being the 5th most populated country in the world with 212 million people, a considerably better GDP rate, a substantial reserve of natural assets and a variety of investment options available in the nation despite that country stayed unappealing to FDI inflows.

Pakistan's manufacturing, agriculture and transport sectors have been hit hard by the energy crisis, although, its consequences are much greater than that. For a developing nation, foreign direct investment is important. Unfortunately, for foreign investors, Pakistan's economic indicators are not promising. The long breakdown of electricity and the shortage of gas presented the world with a poor impression. Pakistan's economy needs investment to expand, but these investments have been held at bay by our energy crisis. World investors are hesitant to invest because they believe that they will not be able to supply the government with the energy to operate factories.

Furthermore, Pakistan's potential investment competitiveness appears poorer than that of adjacent India, but comparable to that of Sri Lanka and Bangladesh. Against the panorama of challenging security conditions, electricity scarcity and a troublesome investment climate, the competitiveness of Pakistan is improving, but very steadily. In the World Bank's 2020 Doing Business Survey, Pakistan was

ranked 108th out of 190 countries, up by 28 positions from a year earlier [11]. This was largely due to a major change in the production of power and the handling of building permits.

4.5.5 Poverty

Reduction in economic development, decreased agricultural production, joblessness and the prevention of industrial expansion contributes to increased poverty. Roughly 40% of the Pakistani population live below the poverty line and the figure is rising day-to-day. Widespread energy crisis management would reduce the threat of poverty.

From its creation on the world map, Pakistan has not addressed the problem of poverty seriously. In the world, poverty persists at 26%, which indicates millions of people living under the poverty line [22]. It is likely to continue amid government efforts. Government officials have come and gone throughout the years, but it seems like the country's leaders have not yet been given the highest importance to seriously ameliorating poverty. All governments have been pursuing the philosophy of 'functional inequality', and more stress has been put on macroeconomics apparently in the belief by keeping in view that these policies will provide the path for development and will help in the creation of more jobs in a 'trickle-down effect. But this neo-liberal phenomenon does not seem to work, as poverty and inequality are increasing at an alarming and persistent pace in the country.

Poverty is rising in the country continuously and people are sick of that, and people have bad feels about the governmental structure. It is dangerous to have increasing frustration and polarization over deteriorating social and political divisions. This could undermine the phase of economic restructuring and disturb the trust of people in the democratic structure. Sadly, rather than looking further for a better analysis of the mechanisms, the new government neglected to provide certain policies and strategies to measure poverty and the living patterns of people.

Poverty is not at all a positive thing, but it is a sin. It is the root cause of many illnesses, anger, hate, poor rule of law, illiteracy, and several other issues. A developing nation like Pakistan does not have sufficient resources to support its citizens with appropriate health regulations, the peripheries are much more important to bear in mind on health and education issues. First of all, the government's allocated funds are not adequate to achieve better health standards and the lack of awareness is perhaps the reason why so many people truly understand little about chronic illnesses. Because of poverty, education levels are very low in Pakistan, people could not afford to have quality education

here, just the upper classes have access to quality education in the country. As education is the remedy to many of a nation's challenges, poverty is the barrier that stands in its path. Furthermore, this blend of health and education difficulties gives birth to several concerns in the soc.

It can eventually be believed that poverty has allowed Pakistan in its stomach, where it would be hard though not unimaginable to recover. There are still a lot of means of getting Pakistan out of this tragedy. Leadership is of great relevance here, and the issue might be resolved with careful planning and effective administrative strategies. Everything they must do is select knowledgeable and well-skilled to enable them to address this issue properly, and their honesty with its remedy should not be overlooked. A country economy is its nation's cornerstone by solving this maze, several other problems will automatically be solved.

Chapter Fifth

Off-Grid Solar Electrification Sustainability and Socio-Economic Prospects

5 Chapter V: Off-grid Solar Electrification Sustainability and Socio-Economic Prospects

5.1 Solar Electrification Sustainability and its socioeconomic aspects

Electricity is a country's primary source of economic, environmental, and social development. Electricity is regarded as humanity's ideal invention, having wrought numerous transformations in human life and civilization. Despite this, over 1.1 billion people on the planet are without power or are suffering from the non-availability of electricity [12]. Rural areas of South Asia and Sub-Saharan Africa are home to the bulk of those affected by this predicament. Similarly, a huge section of Pakistan's population lives in rural areas, with the majority lacking access to power.

Pakistan is a developing country with economic, environmental, and social development issues, all of which have resulted in higher electricity consumption. The country's total electricity requirement is 25,000 megawatts (MW), with a projected increase to 40,000 megawatts by 2030 [32]. The electrical supply, on the other hand, remains about 17,000 MW, resulting in an 8000 MW electricity shortage in the country [43]. According to the findings, electricity shortages occur between 12 and 18 hours each day in both urban and rural locations. Furthermore, the situation in Sindh's remote rural areas is dire, with electrical outages lasting several days. Pakistan does indeed have an abundance of energy resources, including oil, gas, coal, and renewable energy which include solar, wind, hydro, and biomass. Solar energy can create 2900 Gigawatts (GW), wind energy has a potential of 346 GW, hydropower has a potential of 6 GW, and biomass energy has a potential of 6 GW (5 GW) [37]. Sindh is however rich in renewable power generation resources, and the government is supposed to use these to generate electricity. However, the majority of rural areas lack access to energy. Sindh's rural population accounts for 48% of the state's inhabitants, and there are 13,451 villages without electricity in the Sindh province of Pakistan [44]. Because these settlements are dispersed near and distant from the on-grid station, connecting to the grid is both inefficient and costly. Especially comparison to urban areas, the energy requirements in rural areas is minimal, ranging from 50 to 100 Watts (W) each home [49]. Although almost every other house is modest and usually only has one room, only have few lights and one to two fans are required in rural homes. Delivering on-grid distribution to these settlements for such a low consumption is quite expensive, hence grid-connected power is unlikely in the foreseeable future. Similarly, power generated by diesel generating units seems not a cost-effective solution because oil is difficult to deliver to rural areas and is uneconomic and harmful to the climate. Pakistan has a well-structured energy sector that benefits both international and domestic investors. Furthermore, due to substantial development costs, ludicrously and substantial discount rates, short-

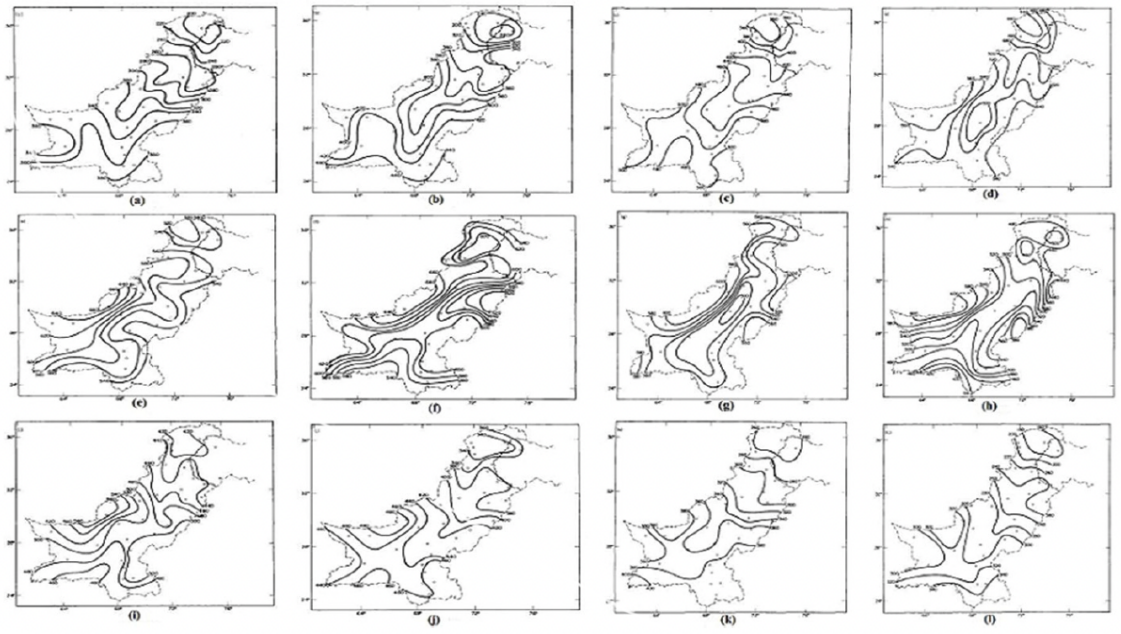
back time demands, a lack of infrastructure prerequisites, remoteness geographies, and the inadequacy of the area's capabilities, decision-makers are reluctant to put money in and pay significant funds and Time and energy to in Renewable technologies. Due to Pakistan's rapidly deteriorating financial environment, the administration has once again called for the stoppage of all currently underway Infrastructural development in the Sindh and Khyber Pakhtunkhwa (KPK) regions, which has had an adverse impact on the advancement of RE channels and more than three billion dollars in capital expenditure opportunities. The province of Sindh tends to agonize the most because of this political verdict, as it has 53 developmental projects in the under-constructions.

Based on the aforementioned factors, off-grid energy is the most promising choice for producing electric power in the whole country including the country's remote zones. All through the year, the region of Pakistan receives a substantial number of solar-energy radiations. The Sindh province does have immense solar energy potency and obtained higher solar radiation exposure, with over 300 sunlight days and approximately 1800–2200 kWh/m2 annual global horizontal exposure to radiation [44]. Moreover, the Asian Development Bank suggested that off-grid solar photovoltaic (PV) is the best choice since it is simple to deploy, inexpensive, and improves the socioeconomic circumstances of remote territories.

Several study results had also postulated the use of off-grid photovoltaic systems to supply the electricity in remote villages. Furthermore, by installing on-site infrastructure, solar photovoltaic eliminate additional expenses. The off-grid solar photovoltaic system was addressed as an adequate and environmentally sound option for power generation owing to its relative cost, gross power generation, and regional ecological quality. In another study, the researchers suggested that the advancement of photovoltaic systems raises the living standards of the people while also improving the region's socio-economic condition. Furthermore, countless other research had also demonstrated that the off-grid solar PV system is a considerable electrification approach and a financially feasible choice for rural areas. In the United States, the household industry has constructed energy-consuming heating and air-conditioning systems, which account for 42% of a building's overall energy usages. Planning is the essential element of electricity administration and financially viable development, such as socioeconomic and ecological development.

5.2 Feasibility analysis of off-grid solution for overcoming energy chaos

Pakistan intends to continue increasing the proportion of sustainable power generation technologies in the total energy mix approximately to 9700 MW by the end of 2030, according to the Medium-Term Development Framework 2006. If the nation uses radiations of solar energy properly and efficiently, it will be able to meet these objectives and address the power crisis. Pakistan is situated in the sunbelt. The nation has immense potential for solar energy. Sindh, Baluchistan, and parts of southern Punjab have a huge amount of solar power generation capacity. The above regions acquire 2 MWh/m2 amount of sunlight radiation and 3000 hours of sunshine annually, making them ideal for investing in solar energy and realizing its full potential [49]. The graphical representation of how much solar radiation Pakistan have throughout a year is given as under



Mean daily solar radiation in Pakistan (cal/cm^2/day) during: (a) January, (b) February, (c) March, (d) April, (e) May, (f) June, (g) July, (h) August, (i) September, (j) October, (k) November and (l) December

Figure 9: Solar Radiation throughout a year in Pakistan

Baluchistan has the enormous capability of solar energy on its own. The typical worldwide insolation is 19–20 MJ/m2 each day, and the yearly average sunshine timeframe is 8 to 8.5 h, making it ideal for solar photovoltaic and other photovoltaic developments [48]. The nation's typical temperature ranges between 260 and 280 degrees Celsius [46]. In the meantime, the ordinary everyday sunlight energy potential is 5.3 kWh/m2. The nation seems to have a total solar power potential of 1,600,000 MW

[43]. If only 100 kilometres of solar photovoltaic panels were installed with a 14 per cent efficiency, Pakistan could generate 30 million tons of oil equivalent to MTOE energy [43].

Pakistan's power generation distribution and transmission system are ageing and inefficient. Solar energy has the potential to alleviate the conventional electric power infrastructure and serve as an alternative to conventional electricity supply in peripheral regions where power grid supply is unavailable. Solar energy is becoming increasingly popular around the world. There is currently work being order to better the storing potential of the cells utilized in photovoltaic Panels. It is also a critical at all at this moment at moment to develop appropriate regulations, accompanied by valued approaches and models for realizing the country's solar potential. In this regard, public-private partnerships can be extremely beneficial. In Pakistan, various solar types such as solar thermal, solar photovoltaics, and desalination are to be chosen. Solar thermal power generation and solar water heating systems, on the other hand, have the enormous capability. The use of solar power equipment efficiently at residence, public areas, and enterprises can reduce dependence on non-renewable energy fuels for electricity production and narrow the current electricity gap between production and consumption. Furthermore, it will ensure the country's long-term development.

5.3 Challenges regarding establishment of full-fledged system of off-grid electrification in Pakistan

5.3.1 Below Average Quality Products

The huge sprawling poor quality solar goods MAs are a substantial hindrance to effective distributive transmission. Almost every household has a solar photovoltaic framework, but nearly every one of them possesses comparatively poor-quality goods (as low as 30 Rs/watt) rather than high-quality goods (around Rs. 100/watt) [34]. Furthermore, people's purchasing power is indeed very limited, making an initial capital expenditure in such high-quality commodities untenable for the wider populace. However, data assessment demonstrates that when other costs such as fuelwood and structure replacement are considered, the high-quality structure seems to become more productive as well as a superior alternative in the long term. Low-quality solar cells have a lifespan of around 2-3 years, whereas high-quality solar cells have a production warranty of two decades. The situation is even worse with battery cells, as citizens continue to use lead-acid battery cells for solar power systems, which are typically reconditioned regionally. Nevertheless, the rechargeable batteries health is as short as one year, as opposed to high-quality gel battery cells, which can last up to five years. The

precise battery performance seems to be determined by the number of discharge cycles. According to a survey of the public, citizens purchase new or reconditioned battery cells every season premiere well before summer. A 200 Amps rechargeable batteries costs between Rs.15,000 and Rs.20,000 [36]. However, a reconditioned battery with a shorter life span is much less expensive. The existence of reduced-quality products poses the greatest challenge, as it builds all the inappropriate developments that influence consumer trust concerns. Furthermore, because of their low quality, these goods are significantly cheaper, making them more appealing to the public who is uninformed of the repercussions. According to stakeholder counselling sessions, Pakistan alone purchased about 1.3 GW of solar panels in 2019, with only 30% coming from tier 1 companies and the rest coming from irregular and small SMEs imports [35].

5.3.2 Inefficacious usage of Solar Photovoltaic Panels

However, one of the serious problems with SHS is unproductive utilization, this not only hinders effective utilization but also causes management and operational problems. The standard approach is to purchase solar cells and battery packs and then hire a local electrician to attach them without any ancillary basic infrastructure such as charge controllers and circuit breakers. Consequently, there is indeed a relatively poor setup of a framework with no one in charge of O&M. As highlighted under, such a structure confronts several obstacles. The very first problem is an inadequacy of maintenance. According to research conducted by UNDP, a homogeneous layer of 10g dust particles accumulated on a solar photovoltaic panel can start reducing its power production by up to 25%, and then when the module is collected homogeneously with 50g of dust, the electricity production would be lowered by estimated 55–63% [34]. Most of the modules on the rooftop have been covered in a dense coating of particulates, and most users seemed to be ignorant of the significance of mopping photovoltaic power panels, particularly in regions surrounded by deserted, mountainous, and covered in dust highlands.

Another problem is a non-optimal angular displacement of panels, which is critical for maximum power generation. In Pakistan, the optimal solar angle for panels is 25 degrees [30]. During the site visits, it was discovered that most of the residences would have solar cells laying laterally smooth on the ceiling. A few commercial establishments perhaps installed them in front of stores with pedestrians passing by, creating shadowing effects. Such practices result in low utilization of solar plate power generation capability. Third, a further major concern brought up by solar retail outlets is the matter of appliances short-circuiting. People frequently abuse the mechanism and unknowingly short circuit it. Most of these frameworks lack a certain sort of overload system, which has a direct

impact on the hardware, particularly the rechargeable battery. Short-circuiting effectively makes battery cells worthless, which becomes a point of contention when consumers request a refund. Such practices are prevented in suitable solar systems by securing the linkage and employing an overload mechanism to protect the appliances. Finally, there are problems with framework overburdening. Aside from relatively reduced-quality solar power systems, some mainstream builders have provided top-tier, tier-1 alternatives to elevated consumers. These developers complain constantly about structure overburdening, tripping concerns, and overall system expense because consumers unintentionally mishandle the framework by attaching unnecessary load. Because of lack of professionally mentoring exercises, any types of problems build public deep mistrust for high-quality goods

5.3.3 Fragile Structure of Hybrid Solutions

A further issue that solar power generation consumers have observed is a lack of facilities for on-grid photovoltaic energy alternatives with rechargeable batteries network storage and grid interconnection. The hybrid model seems to be the most cost-effective solar photovoltaic remedy because it needs fewer backup battery cells and thus costs less than an off-grid structure, which necessitates massive rechargeable batteries. However, for such systems to function properly, they must be accompanied by dependable grid connectivity. Among the most serious concerns is the grid's low power voltage. Distribution networks have been the weakest and most vulnerable reference in the transmission structure, with continuous overloading and voltage decreases. As a result, SHS receives an undependable and low-quality power supply in which either the voltage is too minimal, or the regularity is not preferable. This has an impact on devices that requires grid input at a specific amplitude and current. Interactions with corporate developers working in MAs demonstrated that the power supply can occasionally be as low as 100V, as opposed to the nominal value 220V [30]. To address this issue, stabilizers and voltage regulators are being used. Nevertheless, the prolonged and severe low voltage can sometimes make regulators and stabilizers ineffective. This is frequently exacerbated by load shedding concerns. Because of the prolonged term of power outages, MAs and SHS necessarily need enormous battery backup systems. This tends to result in completely unnecessary expenditures for rechargeable batteries backup systems of 24 to 48 hours, which raises the price of the solar photovoltaic system installation multiple times [32]. Furthermore, the continuous load shedding tends to make it unfeasible for the battery packs to charge upon cloudy weather, resulting in an exponential rise in rechargeable batteries quantities.

5.3.4 Regulatory Difficulties caused by DISCOs

Elevated solar photovoltaic irradiance, a lack of grid transmissions and distributions, and widespread recognizing of solar photovoltaic solutions are all important criteria for distributive generation through the channel of small grids. All these attributes are abundant in these regions, making it an excellent place for redistributive generation arrangement for small and small and medium-sized grids. The existing statutory system, nevertheless, continues to persist as a stumbling block because NEPRA has granted DESCOs an exclusive license as the sole distributor of electricity in MAs. Whatever innovative supply applicant is stymied by NEPRA's distribution exclusivity granted to DESCOs till 2023 [40]. It is necessary to expand the industry, enabling additional private participants to enter and develop a mini grid to closely-knit settlements, which may not perhaps be conceivable if the DESCOs were left undisturbed. The GIZ and KFW schemes for local populations have been funded by microfinancing models in several parts of Gilgit Baltistan, where they have offered a great deal of aid, which otherwise would not be achievable by monopolies. These approaches can be deployed after 2023 when the monopoly for distribution expires.

5.4 Short Summary of New Alternative and Renewable Energy Policy of Pakistan

In the portfolio of regulations encompassing the National Electricity Policy and suggested tariff standardization for the domestic industry at the import phase, the current regime introduced a revised alternative and renewable energy policy-2020. The clean and renewable energy alternate solution strategy proposes to free the importation of plants and machinery imports from existing and new industrial sectors, from import duties and taxes where equipment and equipment are imported into the production of end-user products or components for alternative and renewable energy technology (ARET). Under the current legislation, while imports of fully completed ARET items are exempted from tariffs in certain instances, the machinery and equipment imported by the "industrial enterprise" are subject to 3%, 11%, and 15% customs duties along with sales tax and advance income tax [49]. The only exception is the production of solar PV cells in which the technology is not subjected to any tariff. The production of AREPs or ARET final consumers goods or equipment is discriminated against unfairly. Consequently, this legislation provides that machinery and equipment import from established or emerging industrial companies are generally exempt from duties and taxes in which the plant and machinery being imported to produce AREPs or end-consumer products of ARET or its components.

The significant attributes of the ARE Strategy 2020 provide a range of financing possibilities for leveraging unique ARE resources regarding on-grid and off-grid system domains as well as empowering end customer-driven applications and proposals. Appealing adaptation strategies complement the Government of Pakistan open-door proposals for private financing in ARE sector in Pakistan since this has been originally envisioned to contribute one's proportion in bolstering the power distribution position of the nation and assist to boost accelerated and ecologically feasible monetary expansion. The action initiated in the ARE Strategy 2020 should lay down the required mechanisms for ARE to be completely incorporated into the country's electricity planning and financial and socio-cultural advancement, to the advantage of the citizens of Pakistan [45]. With the involvement of the corporate sector and partnership of the Government of Pakistan focused to keep pursuing the asserted strategies and initiatives. The objective is to pursue to move on to the planned sustainable changeover to much more effective, appropriate, and useful usage of indigenous, clean, and plentiful ARE funds for the ultimate strategic plan of evolution of the nation.

The strategy however has laid down tax benefits for an AREP, namely the ARET electricity production initiative. AREP incentive does include corporate income tax exemption; exclusion from import taxes; repatriation of dividend payments and disinvestment continues; 100 per cent overseas ownership allowable; authorized foreign exchange accounts; safeguards against changes to the legislation; a rigorous contacting structure which is market-tested; and protective measures against seizure of property; global conflict resolution and provinces right over the land of projects [47]. Because of certain discrepancies in the prevailing tax system which discourage domestic production, the bonus seems to be extremely passive for local manufacturing companies to put more money in ARET and international ARET businesses to keep moving to Pakistan, or in partnership with domestic businesses. The strategy suggested that it must confront the above discrepancies to seal the domestic industry up against the ARET renaissance in the nation and around the world.

Many end-user products relying on ARET remain duty-free importable. This continuous tax benefit has not managed to assist in the emerging domestic sector, although it did serve competitive consumption for quite a while. It is a moment for the domestic and international producers to match these products by phased-out of the exclusions. The domestic business sector does have the ability to pay attention quickly to such incentive schemes in cooperation with different producers. A good example is a declaration in 2017 of LED lights as local products, which is a short time led to certain foreign manufacturers establishing LED manufacturing in Pakistan. As a result, the Alternative Energy Development Board (AEDB) will request the Federal Board of Revenue (FBR) and the Engineering Development Board (EDB) to eliminate customs duty waivers on ARET-based consumption goods that

the domestic sector can produce or intends to manufacture. Alternative Energy Development Board will consult with the regional Chambers of Commerce and Industry to evaluate such request. It should have been borne in mind that, since it could be a NEP, if the goods under evaluation need not correspond to sub-components of renewable energy power generation facilities, a concurrent proposal with the Ministry of Industries and Production/EDB could well be required, so in that instance, AEDB involvement may be made underneath the AEDB Act rather than these latest government policies, it introduced.

The Alternative Energy Development Board will continue to monitor the customs duties framework and will intervene quickly with the Federal Government and relevant officials at which the regional production business sector is being disadvantaged by imports, keeping in mind the need to strike an equilibrium between both the lead times domestic economy would need to give a response to consumption and the need for moving potential. The RE (electricity generated using alternative and renewable energy technology) aims within that Strategy are intended to result in favourable effects for the domestic production industry's advancing capacities.

5.5 Brief reviews of Solar Energy Policies of Some Leading Nations

5.5.1 Spain

Solar energy is expected to play a significant role in the electricity landscape in the future, and Spain would undoubtedly be among the leading nations in terms of its consumption, openness, and introduction of advanced technologies. In Spain, 2008 was a hugely important year because the committee created the truly innovative authoritative structure with the actual purpose of exhibiting the latest guidelines, to excuse the astonishing growth of the photovoltaic installation that perhaps the previous system produced, owing to an extremely exceptional FIT. The Real Decreto (Royal Decree) 436/2004 constituted the fundamental underpinning of RES in Spain since September 2008. This extraordinarily powerful program is based on the performer's capacity to choose either to sell the generated energy for a fixed price (expressed as a degree of the benchmark average requirement (RAT)) or to sell that in the public markets using the operating expense. FITs have been allowed for an indeterminate number of decades, with a decrease beyond 2.5 decades.

In 2019, Spain has contributed roughly 4.8 gigawatts to its total of 9.9 gigawatts, up to less than approximately 0.3 gigawatts in 2018 [50]. A large number of deployments has been mainly owing to the completion of ventures awarded in 2017 to fulfil the state's EU requirements, along with Spain's first PPA- and wholesale-based facilities, while also rooftop domestic-usages deployment. Despite the repeal of Spain's "Sun Tax" in November 2018 and the simplification of the approval procedure, the deployment of home-based solar photosystems increased significantly. Grid limitations have been the main roadblocks to massive scheme deployment.

5.5.2 Germany

Germany has been the global industry pioneer in the installation of solar photovoltaic frameworks, with an installed capacity of 3.8 gigawatts in 2017. However, the yearly usage in Germany has been rise nearly 33% comparative to 2018, with and over 3.8 gigawatts added in 2019 to an aggregate installed capacity reached more than 49 gigawatts [51]. Domestic-Utilization and FIT premiums drove the industry, with minimal quantity offer for larger (750 kW) ground-mounted installations accounting for lower to 20% of additional production ability. From 2019 to 2020, the number of producers and consumers in Germany climbed by about 100,000 [51]. A rechargeable battery storing device has been delivered alongside one out of every two rooftop deployments, according to estimates. The German administration declared a proposed target of 98 gigawatts solar photovoltaic panels to be installed by 2030, and the 52 gigawatts feed-in tax limit had been questioned. Throughout this fiscal year 2019 to 2020, solar power produced approximately 8.2% of Germany's energy total demand [51].

Underneath the boundary constraints used in this study, the financial research revealed that system linked photovoltaic schemes are still not commercially feasible in Germany. In whatsoever event, people certainly would have an advantage if longer-lasting frames with a lifespan lasting approximately to 4 decades were to be available. Furthermore, despite calculations based on FIT, plans show that Photovoltaic structures with such a reduced structural life duration (for example 25 years) are still not economically viable.

5.5.3 South Korea

The structure differs significantly from the existing situation, which shows a gradual reduction in the usage of coal and nuclear fuel as the utilization of gas and alternatives energy sources for power generation increased from 2017 to 2031. By 2030, South Korea wants to use alternative energy sources approximately 20% of its total energy consumption. To meet that goal, Asia's fourth-largest

economy plans to increase its conventional limitations of sustainable potential to 58.5 gigawatts by 2030, up from 11.3 gigawatts during this fiscal year [52]. According to the Energy Service, the agreement provided for a limitation of 30.8 Gigawatt of solar-based electricity generation and 16.5 gigawatts of wind electricity generation. South Korea currently generates more than 70% of its power through coal and nuclear fuel, with alternatives energy sources accounting for only 6% [52]. As per the Global Status Report names as Sustainable Power Source Policy Network for current Century REN21 (2016) Renewables 2016, a great number of energy phase would then fall to 36.1% in 2030 and nuclear to 23.9%, but the sections can still create a significantly larger portion of the country's accumulated energy.

5.5.4 China

The development may have massive ramifications in terms of power consumption and general effect. Carbon emissions are a common problem related to power usage. Regardless, China's carbon emissions are modest on a per capita basis, and the country has currently the world's second greatest emitter of carbon emissions, after only America. It is estimated that 75 per cent of China's tainting is a direct result of the country's insatiable want for coal as a key energy source, which accounts for a mind-boggling share of the country's total use. Even though this share has been declining since late, it may be excessively large in a lot of nations. With the rapid rise in utility prices, solar panels have become more popular, and it has provided enormous ecological and financial benefits. In China, the central government devised some systems that were implemented across the country. Over the last five years, a few firms had produced a vast array of equipment. China has a large capacity for solar energy. Beginning later, it is being discovered that unusual solar power aspects had significantly reduced the expense of photovoltaic regulation management. In 2007, for example, the Photovoltaic age limitation rate became 4 Yuan (US Cent 58.9)/kWh [53]. The leading Chinese photovoltaic panel manufacturers, Sun Tech Power Co., Ltd, announced in 2008 that they had developed the finest photovoltaic panel in the world. Sun tech Power Co., Ltd started in 2008 that by 2012, the photovoltaic management price would be 1 Yuan (US$ 0.15)/kWh [53]. Furthermore, the Photovoltaic subsidy in 2009 lowered the photovoltaic life value to 0.69 Yuan (US$ Cent 0.1)/kWh. China had lured to select its next power approaches as the density of carbon continues to shrink. Alongside the Solar renewable energy unrelenting techniques, it seems to be anticipated that photovoltaic displayed point of confinement would make rapid progress.

5.5.5 India

India, the second-biggest marketplace in Asia and the third largest internationally, installed 9.9 gigawatts in 2019, bringing the aggregate to 42.8 gigawatts. India intends 100 gigawatts of solar photovoltaic cells deployed until the final hour of 2022 [54]. This includes 40 gigawatts of roof-mounted solar power panels over the homes of the citizens. Since experiencing substantial expansion in 2018, India's yearly deployments dropped in 2019. There are numerous justifications for this decrease: India's economic depression, border tax caps, elevated tender involvement expenses, billing deadlines, renegotiating energy consumer buying contracts in Andhra Pradesh, property buying difficulties, absence of transmission infrastructures and easier connectivity to the transmission network, low cash flow along with a dearth of sources of finance. Suppression also had acted as a roadblock to fresh deployments, and the magnitude has been exacerbated with a decrease in energy stipulations as the economy weakens. The central administration regime named it as a “must-run” position for solar photovoltaic and wind energy initiatives in August, but the potential to purely implement the guidelines was inadequate. Nonetheless, a photovoltaic system for the period has been up 27% against 2018 [54].

Over 85% of Indians recently deployed aptitude considered for megaprojects representing a significantly large part of aggregate solar photovoltaic capacity. In 2019, approximately 35 gigawatts of tenders had been introduced in India, an 8% decrease from 2018, with more than 15.8 GW of projects auctioned [54]. However, numerous proposals have been undervalued, and several auctions had been forced to dismiss retrospectively, that was the case in 2018. Even though, approximately 23 gigawatts of massive-scale potential projects have been under in the pipeline in the final hour of 2019 [54].

In 2019, for the very first moment in five years, India's rooftop market has dropped significantly. The recession has been primarily caused by the financial downturn, along with low cash flow, but also hurdles to total metering and long and complex regulatory permission in certain regions. Across the year, an approximated 1.1 gigawatts of dispersed and off-grid potential have been managed to deploy. The rooftop industry has been remained dominated by sizeable commercial and industrial firms.

5.6 Socioeconomic advantages of off-grid Solar Electrification

5.6.1 Reliable access to electricity and higher rate of Power Production

Electricity becomes a critical determinant of economic development and human advancement. Reliability and regulatory regime persistence have been essential to optimizing the importance of power generation in advancement. The United Nations acknowledges the significance of the availability of electricity supply services in its Sustainable Development Goal (SDG) 7, where it aims to deliver all humans on the globe with availability to affordably priced, consistent, and climate-resilient advanced power generation (United Nations, 2015). As per the SDG official documents for 2019 and 2020, the quantity of individuals without connectivity to electric power has decreased from 1.2 billion in 2010 to 840 million in 2017, and then to 789 million in 2018 [22]. The electricity-generating percentage, or connectivity rate, is the principal measurement was using to monitor SDG7, but also because it has always been binary, this only offers volume importance for evaluating modern energy, and thus seems to be insufficient. To begin to grasp higher customer experience, we investigate the configuration and outcomes of an innovative measurement that sought to identify the lowest possible requirement for a pretty good or reliable electricity facility. Enhancing initiatives to strengthen the consistency of the power may not only make sure that households possess access to electric power, but it might also guarantee that businesses can have access to the power supply they require for production.

Pakistan has abundant sustainable energy sources including wind, solar, hydro, and biomass. Such supplies could make significant contributions to the country's long-term power generation matrix, mitigating climate shift endeavours, and renewable power advancement. People in Pakistan are currently installing solar photovoltaic panels to help alleviate the country's electricity production shortage. If they produce more electricity than they need, they can sell it to the government of Pakistan.

Solar technology price levels in Pakistan had already dropped dramatically in recent years, potentially letting solar photovoltaic cells quite accessible for middle-class home-landlords though too. Furthermore, new technologies have advanced and are becoming quite efficient and profitable. Rooftop Solar photovoltaic solutions reduced gross power expenses to half and defend building owners from rapidly increasing tariff barriers. It is a true industry significant development. It used to

take ages to receive permissions from the National Electric Power Regulatory Authority for net-metering. However, it now only tends to take a handful of working days and creates the power generation nearly free by looping the leftover units of energy generated throughout the day back into the power stations. NEPRA must have accepted 6,709 net-metering permits for 116.2 megawatts of electricity-producing potential throughout the nation. Among these, 5,615 licensees have perhaps put their 87.92 megawatts capabilities into service [40].

5.6.2 Increment in Agricultural Production

Energy does seem to be the most essential source of energy for agricultural advancement and productivity. Pakistan, as an agrarian nation, has been confronted with energy and water dearth challenges, in addition to reduced productive output and soil erosion. Increased agricultural yield to satisfy growing populace requirements might be a significant hurdle for agricultural production. A dearth of energy and water have always been two significant impediments to sustainable agriculture and food security. Sustainable agriculture refers to farming methods that do not harm the ecosystem or subsequent generations, whereas food security refers to food availability to all sorts of different people for a healthy and vibrant lifestyle in the world today, as well as the capacity to offer in the coming years.

The existing method in agricultural production in Pakistan could be to create electricity using fossil fuels, which is costly and ended up causing Greenhouse gases, which exacerbates the global warming mechanism. To ameliorate global temperature transformation and minimize Greenhouse gases, conventional fossil fuel-based electricity production must be replaced with sustainable energy production resources. Renewable power resources that do not rely on fossil fuels involve solar, wind, biomass, hydroelectric, and geothermal. Electricity and water lack of supply concerns could indeed be alleviated by using sustainable, clean, and renewable energy sources, which might eventually help to minimize ecological harm and global warming.

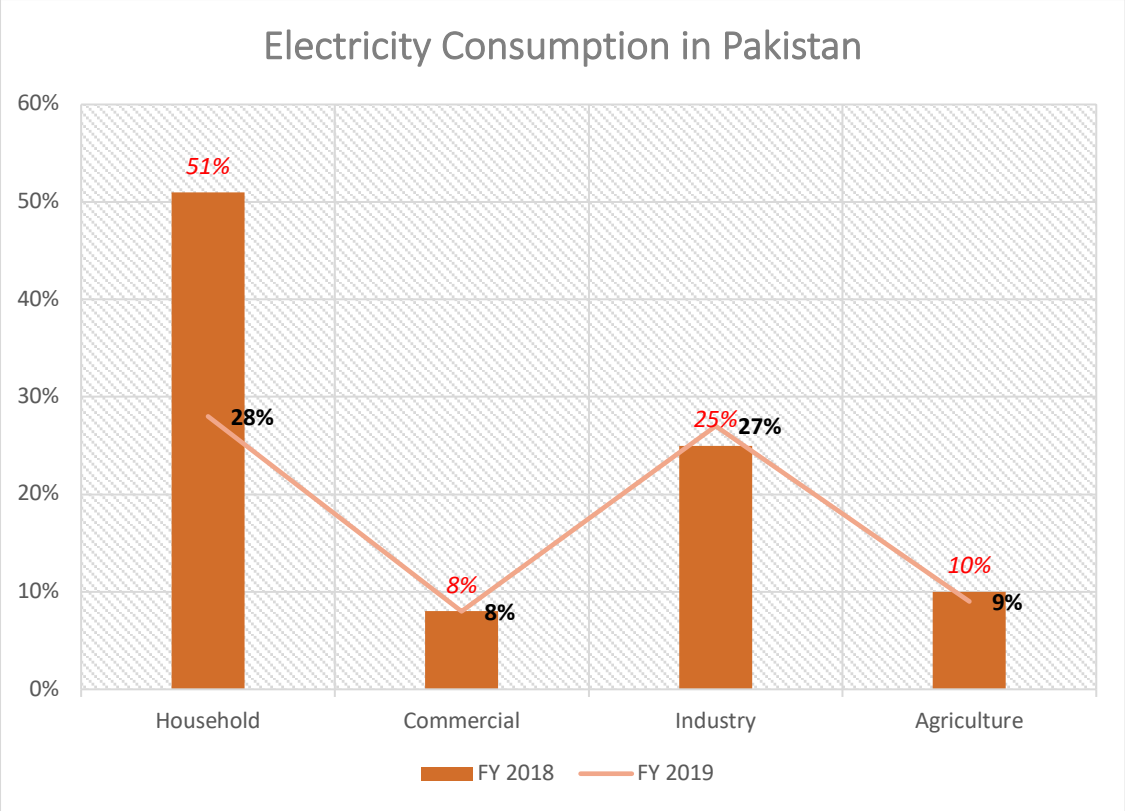
Pakistan, more particularly its four provinces of Punjab, Sindh, Khyber-Pakhtunkhwa, and Baluchistan, has diverse weather patterns, environmental, and socioeconomic functionalities that outcome in a distinguishable agro-based production mechanism. Wheat, rice, cotton, sugarcane, and maize do seem to be suitable for cultivation in Pakistan, with huge regions, sizeable output, and massive exports. Punjab region has been considered as the heart of Pakistan thanks to the huge agricultural fields, accounting for 72.82% agricultural zone, accompanied by Sindh at 14.20%, Khyber-Pakhtunkhwa at 8.39%, and Baluchistan at 4.67% [20]. The agriculture industry in Pakistan employs

the greatest number of people, and it has been one of the primary sources of revenue for people in rural areas in all regions. The Punjab province has the largest proportion of labour force, accompanied by Sindh province at 24%, KPK at 11%, and Baluchistan at 4% [20].

The utilization of alternative power resources in agriculture generation methods cannot just help in solving electricity and water insufficiency issues but might also guarantee food security and improve environmentally friendly farming in Pakistan. The massive switch toward enhanced sustainable energy can start reducing the nation's reliance on fossil fuels, minimize import bills, and offer additional significantly larger savings. This could perhaps allow us to satisfy the UN Millennium Development Goal of 2007. The consumption of alternative power resources could further help to increase soil quality while reducing the demand for fertilizer, pesticides, and herbicides.

5.6.3 Economic Development

Energy has been an essential component of any nation's economic advancement. Electricity seems to be a remarkably adaptable source of power that can be used to boost the productivity of nearly any sector of the economic system. Pakistan's catastrophic electricity malfunction regulations had abandoned the country in the grip of a serious energy crisis, causing economic devastation over the last two decades. As a result, acknowledging power utilization and real GDP would be critical for improving the country's financial development mechanism from a strategy point of view. The undisrupted supply of electric power has become an important component in the manufacturing sector's success. It has always been critical since this segment is indeed the backbone of economic development in Pakistan. Nevertheless, Pakistan must have been dealing with a serious power generation downturn, both intrinsically and extrinsically, affecting most areas of the economy. In the Past, energy scarcity and mismanagement have negatively affected the economy. Although during the timespan of 2013–2018, the administration implemented several strategies to address the electricity problem and ensure the seamless transmission of electricity. Such projects appended an average of 12,230 megawatts of electricity to the country's power sector. The utilization trends of electric power demonstrated that there had been no significant alteration in electric power need. The manufacturing industry furthermore showed a 25% increase in electric energy utilization in 2018 and a 27% increase in 2019: nevertheless, commercial usage unaffected from 2018 to 2019 [40]. Power utilization in the agricultural segment has been dropped by 1% in 2019, from 10% in 2018 to 9% in 2019 [40]. The increase in the manufacturing industry electric power usage becomes a promising indicator that the industry is trying to regain out from prior financial loss, but some other segments still require further refinement. The consumption of electricity of is represented into the given graph.



Graph 12: Electricity Consumption in Pakistan

Data Source: National Electric Power Regulatory Authority Pakistan

Solar photovoltaic power is critical in meeting the manufacturing industry's power requirements. Solar Water Heating becomes particularly important since water heating uses up a considerable portion of power worldwide. It is discovered that heating water uses up 15 to 20% of overall national electric power usage [42]. Water heating has been essential in the manufacturing industry, just as it has been in household uses. Heated water is being utilized in a variety of industrial mechanisms. The textile business sector uses 65% of its electricity to heat water for various reasons. According to previous studies, Pakistan seems to be using 10% of its national electric power to heat water. As Pakistan's population grows, so does the electricity consumption for household and industrial reasons. Most of this electricity is being utilized to heat water. Pakistan's textile sector accounted for 60% of overall export revenue. At the same time, the textile sector does use heated water whose temperature level is approximately 80 °C for a variety of purposes. As a result, solar photovoltaic power has become a feasible alternative for both domestic and industrial requirements in Pakistan. This contributes to the Industrial development that leads to economic development.

5.6.4 Better Education access to poor and remote regions

Education is often brought forth as a potential benefit from the improved light, but often little empirical evidence or experiences are underlying these claims. As per the Punjab Government, over 10,000 primary schools had been decided to convert to the solar photovoltaic system as part of an 86-million-dollar program financially backed by the Asian Development Bank (ADB). Progress, therefore, seems to have officially started on incorporating solar renewable power generation into sanctuaries. In collaboration with a Pakistani organization, a corporation would then build a 100-megawatt solar power station in Layyah this year, while 550kW hybrid solar-biogas developments are being built in Sammundri and Vehari at an expense of Rs282 million [43]. In addition, the 2.5-megawatt solar photovoltaic power station at Islamia University Bahawalpur would be managed to complete in 2021 [42]. It has been estimated that the institution will save Rs55 million in annual bills because of this initiative. ADB would however financially support the construction of an eight-story net-zero facility for the Punjab Energy Department in Lahore. In aspects of electric power consumption, it may be a one-of-a-kind structure.

Researchers have investigated the successfulness of the strategy concerning electricity consumption of schools produced through solar photovoltaic panels considering school level information of 21,412 schools all over 176 municipalities in Pakistan from 2013 to 2018 [20]. Through applying an estimate of differences, researchers assess whether the approach ultimately results from the discrepancy in admission among the schools that belongs to the Punjab region, where the strategy was implemented, and other places of Pakistan where the strategy had not been executed, through monitoring for school and infrastructural facilities. Consequently, researchers divided the sample size of 5,444 schools from Punjab as treatment schools and 15,968 schools from the rest of Pakistan as control schools [46]. Researchers achieved the result with convincing indications that the Punjab administration's decision of deploying solar photovoltaic plates in schools contributed to elevated admission especially in comparison to students enrolled in schools somewhere else in the country. Following the execution of the strategy, average student admissions for each school in Punjab risen by 48.5 students when contrasted to another similar admission for each school anywhere else in Pakistan. As per a gender breakdown outcome, the average student enrolment rate for each school in Punjab elevated by 24.1 schoolchildren only after the strategy was implemented, particularly in comparison to average students enrolled per school elsewhere within Pakistan. At the very same moment, while strategy was implemented, the average student registration rate for every girl’s school in Punjab improved by 48.5 students when compared to other similar registration so for every girl’s school wherever in Pakistan.

Correspondingly, afterwards, when the plan was implemented, the average registration of mix-gender per school in Punjab managed to improve by 54.1 students when compared to the corresponding matriculation from each school everywhere across the country.

Nevertheless, there has been very little analysis into how solar photovoltaic electric power will enhance instructional results and upsurge access to education. Solar photovoltaic electric energy, through lowering entry obstacles and supplying cheap and ecologically friendly production alternatives, may well be the operational advancement required to overcome the issues of achieving the Sustainable Development Goals and improve education access to poor and remote regions of Pakistan

Chapter Sixth

Conclusion

6 Conclusion

6.1 Policy Recommendations for prosperous development of Off-grid electrification in Pakistan

Government strategies have been developed and enacted with the intersection of industries, advanced technologies, and citizens in mind. Nevertheless, when decades-old national plans have become passive or incapable of evolving, they cause more permanent damage than better services to the people of that nation. Markets have become devoid of reality and isolated, aged methods are being used to restrict the chance to break away and most notably the demands of individuals have been neglected, creating additional political alienation.

Currently, in Pakistan, there seems to be a deep divide in government policies regarding the electrification of different regions of the country. Over the decades of commercial, legal, and technologically centralised power grid have been distributed without cost-benefit evaluation. Legislation, management, and regulations demonstrate years of a strong focus on the predominant facility framework of electricity mechanism, transmission, and distribution. Furthermore, all financial support and operational processes for building projects, siting, budget control, surcharge recovery, and tax incentives are mainly focused on DESCO. The consequences have been insignificant for end customers who keep living in energy-inefficient environments. The public's interest in government legislation has still been lacking. Policy recommendations to overcome the energy crisis, achieve socio-economic development and promote solar photovoltaic electricity generation in the country are given under

Make data on Sustainable Energy Resources available by region

The sustainable energy resources of the majority of remote regions of Pakistan had not been charted on the ground, that further delays development plan implementation. Pakistan Council of Renewable Energy Technologies along with the Alternative Energy Development Board could chart the relevant information and make it accessible to the corporate industries for economic advantages of the region and of the whole country

Sites allotment for small off-grid facilities to the corporate sector

off-grid Initiatives might not be inspired or undertaken if land for facilities for sustainable power production in regions where renewable energy resources are occurring to a great extent to attract a competitive market.

Introduction of Upfront Tariff

National Electric Power Regulatory Authority has still to unveil upfront tariffs for solar photovoltaic, small-hydro, and biomass power initiatives, which creates budget forecasting challenging. As a result, National Electric Power Regulatory Authority must develop a tariff framework right away.

Incentives for special Microfinance projects.

Non-Governmental Organisations like the Buksh Foundation have been aiding in the provide solar photovoltaic units in remote regions with a gender empowerment ideology. The procedures of trying to broaden small town electrification initiatives can be accelerated by giving tax benefits and subsidised hardware to such organisations.

Sustainable Energy Development Fund

However, to promote charitable contributions from domestic and worldwide organisations, the federal government must construct a Sustainable Energy Development Fund with the fundamental goal of community development and for funding off-grid projects in the whole country.

Building Institutional Capacity at the National and Provincial Levels

Due to a severe shortfall of power generation on the national electric grid and economic restrictions, government entities dearth the workforce and professionalism to appropriately meet the needs of people to the sustainable off-grid power supply. Among such establishments, specialised professional courses and the establishment of individual task groups can optimise operating efficiency and collaboration with other divisions.

Renewable Energy Research Institute.

The Pakistan Council of Renewable Energy Technologies seems to be the sole advisory body that directs sustainable power studies among academic institutions; however, there has been no specified establishment for renewable energy technology research and development, as well as mentoring to strengthen the abilities in that field.

Sustainable Power Generation added at least 30% by 2025 to National Grid Station

Pakistan will not be able to inspire adequate venture capitalists in renewable power for the off-grid sector till the Federal Administration affirms itself as a great promising marketplace. With precedents in China and India, achieving this great achievement can lure global collaboration for massive off-grid electricity projects in Pakistan.

Green Energy Tax

Access to finance for the modernisation of sustainable power production in the nation is scarce. As a result, the current regime may levy a tax on the corporate segment of the economy on the usage of carbon fuels and reinvest the funds raised for the installation of advancement of green technology for remote regions of the country.

Carbon Credits

Developing a long-term strategic plan for providing carbon credits to different size electricity consumers may start encouraging corporate entities to participate in renewable technology and catalyse its recognition across the nation, while the credits can however act as an additional source of earnings for the rural population that uses environmentally friendly technologies.

The regulatory suggestions outlined earlier highlight the important key players associated with the matter, bring to light significant problems confronting by sector, as well as provide a coherent and

consistent response for developing a sustainable power generation mechanism for Pakistan's off-grid sustainability.

6.2 Conclusion

With Pakistan's severely unreliable power supply and perhaps one-third of people living off the grid, long term electric power resilience and consolidation have been critical for the nation's wellbeing. The rural region of Pakistan has an undiscovered significance that will not significantly raise the agrarian sector's participation in national Gross Domestic Product through power generation but might also reshape the state's economic system with the help of small-scale enterprises. Pakistan does have a variety of renewable sources for a small town to generate electric power for their daily usage; however, the state's geographic location, political and socioeconomic elements make financially viable electricity generation nearly impossible. Therefore, it necessitates the use of emerging technology solutions and a better strategy to promote renewable sources for power generation. With such a massive sustainable resources energy capacity, unparalleled advancements in the solar photovoltaic units and hydro-powered industrial segment, and a detailed assessment of related initiatives in emerging nation-states, it is clear that a comprehensive strategy among both the federal administration, the regional authorities, and gigantic ventures have been required for successful and sustainable power generation for the region's remote regions. Financing in emerging technologies by corporate institutions of the country makes logistics easier and calls for collaboration among the public and private segments to solve the country's power turmoil.

In conclusion, this analysis emphasises the significance of initiatives relating to solar photovoltaic power generation, which has been regarded as crucial alternative fuel for the coming decades. Decision-makers need to recognise that, in the future, dependence on solar photovoltaic energy may be critical in addressing the socio-economic challenges which Pakistan is facing today. Solar photovoltaic power is related to the continuous optimisation of living conditions for individual citizens in specific, as well as societies in a broad sense through the sustainable supply of electric power to both remote regions as well as to well-developed regions of the country without increasing the greenhouse gases concentrations into the atmosphere. With the help of this method, the transmission and distribution losses of the country can be minimised to great extent. Even in schools, the use of solar photovoltaic electric power does seem to be critical in reducing obstacles and enhancing educational performance. Raising awareness for policy initiatives that increase reliance on solar

photovoltaic power generation is however essential in achieving the Sustainable Development Goals, which would probably stay nothing but a distant reality.

Acronyms and Abbreviations

7 Acronyms and Abbreviations

IMF	International Monetary Fund
ADB	Asian Development Bank
SBP	State Bank of Pakistan
FY	Fiscal Year
GPD	Gross Domestic Product
GNP	Gross National Product
PBS	Pakistan Bureau of Statistics
FBR	Federal Board of Revenue
SAARC	South Asian Association for Regional Cooperation
OIC	Organization of Islamic Cooperation
SCO	Shanghai Cooperation Organization
ECO	Economic Cooperation Organization
WHO	World Health Organization
WTO	World Trade Organization
LHW	Lady Health Workers
HDI	Human Development Index
COVID-19	Corona Virus Disease 2019
GWH	Gigawatt Hour
MWH	Megawatt Hour
CPI	Consumer Price Index
USC	Utility Stores Corporation

FED	Federal Excise Duty
WPI	Wholesale Price Index
CAD	Current Deficit Account
CPFTA	China-Pakistan Free Trade Agreement
BE	Budgeted Expenses
EDE	Electric Data Exchange
PATHFTA	Pak-Thailand Free Trade Agreement
PSFTA	Pakistan-Sri Lanka Free Trade Agreement
PIB	Pakistan Investment Bond
GFN	Gross Funding Needs
PSLM	Pakistan Social and Living Standards Measurement
HEC	Higher Education Commission
EFF	Extended Fund Facility
MSCI	Morgan Stanley Capital International
EM	Emerging Markets
SECP	Securities and Exchange Commission of Pakistan
MCB	Muslim Commercial Bank
KSE	Karachi Stock Exchange
PSX	Pakistan Stock Exchange
GHG	Greenhouse Gas
ESRI	Eco-system Restoration Initiative
NDC	Nationally Determined Contribution
LDN	Land Degradation Neutrality

ESRF	Eco-Restoration Fund
MOCC	Ministry of Climate Chang
HESCO	Hyderabad Electric Supply Company
KE	Karachi Electric
IESCO	Islamabad Electric Supply Company
PESCO	Peshawar Electric Power Company
MEPCO	Multan Electric Power Company
QESCO	Quetta Electric Supply Company
SEPCO	Sukkur Electric Power Company
LESCO	Lahore Electric Supply Company
TESCO	Tribal Electric Supply Company
GEPCO	Gujranwala Electric Power Company
FESCO	Faisalabad Electric Supply Company
PARCO	Pak-Arab Refinery Company Limited
LNG	Liquified Natural Gas
CNG	Compressed Natural Gas
BCFD	Billion Cubic Feet Per Day
PAEC	Pakistan Atomic Energy Commission
WAPDA	Water & Power Development Authority
DISCOs	Distribution Companies
NEPRA	National Electric Power Regulatory Authority
NTDC	National Transmission and Dispatch Company
RLNG	Regasified Liquefied Natural Gas

ARL	Attock Refinery Limited
BPPL	Byco Petroleum Pakistan Limited
SBM	Single Buoy Mooring
CPPA-G	Central Power Purchasing Agency Guarantee
T&D	Transmission and Dispatch
TOU	Time of Use
IPPs	Independent Power Producers

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9 List of Figures

10 List of Tables

11 List of Graphs